LAKE SUPERIOR STATE UNIVERSITY

Academic Program Review

DUE DATE: November 21, 2018

The HLC Criteria for Accreditation, specifically Core Component 4.A, require institutions to maintain a "practice of regular program review[1]" as one component for ensuring the quality of our educational programs and evaluating our effectiveness in achieving our stated student learning outcomes. For academic units, "Program" means an academic School.

School:	**School of Science and Medicine**
Degree Programs of the School: (indicate which, if any, hold specialized programmatic accreditation)	• **B.S. Biology** **Pre-Medical Concentration** **Pre-Veterinary Concentration** • **B.S. Biochemistry Pre-professional - accredited by the American Chemical Society (ACS)** • **B.S. Chemistry - accredited by the American Chemical Society (ACS)** • **B.S. Forensic Chemistry - accredited by the American Chemical Society (ACS)** • **B.S. Medical Laboratory Science - accredited by National Accrediting Agency for Clinical Laboratory Science (NACLS)** • **A.D. Chemistry** • **A.D. Chemical Technology**
Academic Program Review Submission Date:	
Dean:	**David Myton, Ph.D.**
School Chair:	**Barbara Keller, Ph.D.**
Names of Faculty Members Completing Program Review Report:	**Barbara Evans, Ph.D.** **Jason Garvon, Ph.D.** **Martha Hutchens, Ph.D.** **Alexei Iretski, Ph.D.** **Steven Johnson, Ph.D.** **Barbara Keller, Ph.D.** **Stephen Kolomyjec, Ph.D.** **Jun Li, Ph.D.** **R. Adam Mosey, Ph.D.** **Thu Nguyen-Mosey, Ph.D.** **Britton Ranson Olson, Ph.D.**

[1] https://www.hlcommission.org/Policies/criteria-and-core-components.html

	Matthew Spencer, Ph.D. **Gregory Zimmerman, Ph.D.**

Guidelines for Completing the Academic Program Review

Questions in Part 1 are focused at the School level, and should reflect School-level data, findings, etc.

Questions in Part 2 should be completed for each distinct academic degree program in the School. In the cases where an academic degree holds specialized programmatic accreditation, Schools can cite the page(s) which address the prompt question. In all cases, attach evidence where available using the appendix cover sheet to identify how the evidence supports the relevant criteria or prompt.

PART 1: School-Level Review

School Mission and Goals

1. Provide the School's mission statement and explain its connection to the University mission.

Our mission is to produce exceptional graduates through emphasis on rigorous applied programs, hands-on experiences, and interaction with highly qualified faculty members who are centered on student success.

Our vision is to inspire and prepare students to positively change the Upper Great Lakes Region and beyond through science.

2. List the School-level goals and explain how they support and connect to the CAFE Master Goals of the Strategic Plan.
https://www.lssu.edu/wp-content/uploads/2018/09/2018-2023-LSSU-Strategic-Plan.pdf

The School of Science & Medicine goals and their connection to CAFÉ are:

Culture

The School of Science and Medicine will cultivate an environment of collaboration and inclusion for students, faculty and staff in all fields of study.

Assessment Plan:

1. Collaborations of school faculty and students within and outside of the university will be listed.
2. Survey of faculty, staff and student perceptions of College culture.

Academics

The School of Science and Medicine will promote faculty-student interaction, high-quality classroom instruction, hands-on research opportunities and advising.

Assessment Plan:

1. Research projects, pictures of the student research symposium, abstracts from the student research presentations will be reported.
2. Advising reports from the faculty.
3. Examples of teaching innovations
4. Student responses/feedback from survey
3. Faculty and student grants and research will be listed.

Finance

The School of Science and Medicine will promote transparent fiscal responsibility in all budgetary processes including the collection and allocation of course and program fees to meet the needs of our students and programs.

Assessment:

1. School spending will remain within budget.
2. School will build a prioritization list for equipment replacement and purchases

Enrollment

The School of Science and Medicine will improve recruitment and retention

Assessment Plan:

1. Outreach programs with K-12, community colleges, tribal partners and other organizations will be reported.
2. School retention will be consistent with or better than the overall university retention.
3. The development and use of marketing materials, by ourselves and in collaboration with the University marketing team, will be reported.

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Explain how the School works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Teaching and Learning Programs Evaluation and Improvement (CC 4.A)

3. Explain how faculty determine program and course learning outcomes, course prerequisites, rigor of courses, expectations for student achievement, and student access to resources.

Faculty within the school are experts in their disciplines. The course learning outcomes are determined by the faculty who are teaching the particular course based on their knowledge and expertise in the subject area. The outcomes reflect the student activities and performance that will be measured and evaluated by the faculty member to ensure that the students understand key concepts of the course material that are pertinent for their overall success in the program. Methods for measurement may include, but not be limited to, exams, quizzes, written reports, presentations, etc. The rigor of the course is determined partially by the level of the course (e.g., lower level courses have less rigor than higher level courses). It is the faculty member's responsibility to ensure that students will have access to the necessary resources to successfully achieve the course learning outcomes.

4. Explain how faculty ensure the equivalence of learning outcomes and achievement in all modes and locations where degrees are delivered. Provide examples of course syllabi from multiple delivery modes and locations of the same course(s).

The degrees for the School of Science and Medicine are delivered only on the main campus. Some courses within the degrees are delivered off campus. Faculty members within the school are assigned oversight for these off campus courses. Instructor credentials are evaluated by the faculty to ensure that they have the proper educational background to teach the courses. Common syllabi are utilized for on-campus and off-campus courses. Learning outcomes for the on-campus and off-campus courses are the same. Typically, a faculty member will do an onsite visit during the initial off-campus course offering to ensure that the facility has adequate equipment and resources. Off-site instructors are encouraged to give the same exams, quizzes, etc. as those that are given in the on-campus course.

5. If applicable, attach the most recent report, findings and recommendations from specialized programmatic accreditations within the School.

   See attached reports for the medical laboratory science and chemistry programs.

6. Report data from the past two years to show what students are doing after graduation from the programs in your School. For example, statistical data should report the numbers of students in

specific areas (*i.e.,* business, government, education, military, unemployed, pursuing advanced degrees, etc.). Attach representative data.

A survey of students returned 45 responses of students in the School who self-identified as graduating 2012 to 2018. Of those 45 respondents 37.8% entered employment in their field, 44.4% entered professional or graduate schools, 6.6% were working outside of their field of study, 6.6% continued on doing internships or started a new field of study (nursing), and 4.4% were unemployed. A copy of the survey results is attached.

Assessment (CC 4.B and CC 4.C)

Explain how the School uses assessment to promote ongoing growth and improvement. As evidence for each question, you may choose to include content from the 'Use of Results' column in the 4-Column Program Assessment Report, or provide broader assessment results from an alternative source.

7. School-level goals and their connections to the university's CAFE Master Goals Strategic Plan were listed in Question 2 of this report. Select 3-5 of those goals as a focus for the School's 4-Column School Assessment Report; add the selected goals to the 4-Column report document, and attach the document.

   See attached report.

8. Describe how results from assessment have been used to improve your School. Include specific examples.

The school continually evaluates curriculum and its impact on programs. As an example, several years ago the chemistry faculty deleted the CHEM220 Survey of Organic Chemistry class after consultation with faculty from the disciplines who utilized the class. The general consensus among the faculty in the various disciplines was that students who utilized CHEM220 could instead utilize CHEM225 Organic Chemistry I, the first semester of a two semester sequence in organic chemistry, that is used by chemistry majors. Assessment of this change several years later showed that students who typically would have taken the CHEM220 survey course (students in fisheries, wildlife, etc.) where not successfully completing the CHEM225 course that delved more deeply into organic chemistry. As a result, a new CHEM208 Survey of Organic Chemistry with Biological Applications has been introduced as a new course to better serve the students who previously had taken CHEM220 or CHEM225 for their programs.

Over the course of several years, the faculty had consistently asked for more research space for themselves and their students. With the school reorganization to include biology and chemistry, an assessment of courses revealed that there was enough similarity in the facilities and equipment needed to teach genetics and biochemistry, that the two physical laboratories, where they each were taught, were not both needed. The school proposed moving the biochemistry laboratory into the same laboratory as genetics. This allowed the school to turn the former biochemistry laboratory into a research space for faculty and students.

Further assessment of laboratory space revealed that the dark room was underutilized for research or courses. This space was revamped and is now utilized as a fish culture facility.

9. Describe how the School uses assessment results to inform and facilitate better planning and budgeting.

The school assesses and evaluates annually the need for specific equipment and instrumentation in the courses and programs. As a result of that evaluation, the faculty within the school annually develop a prioritized list of larger equipment/instrumentation so that the needed equipment may be budgeted for and purchased with program fees. Additionally, each year the school faculty readjust course fees to ensure that the revenue that is collected is sufficient to purchase smaller pieces of equipment, chemicals, biological samples, etc. that are required by the courses.

10. In addition to LSSU's campus-wide programs designed to support retention and degree completion, list any additional activities of the School specifically intended to increase retention and degree completion.

The School supports retention and degree completion in a number of different ways.

- *Freshman students are all required to take a course devoted to a first year experience. Those courses include a specific biology course (BIOL199) and chemistry (USEM101). In these courses, students learn how to navigate through their university experience and become part of a "family" specific to their declared discipline.*
- *The school faculty mentor student organizations/clubs such as the Chemistry & Environmental Science Club and the Pre-Professional Society where students of similar disciplines meet and socialize together.*
- *The Chemistry & Environmental Science Club is housed on-site in a Living Learning Community where students are able to study, socialize, and interact with faculty mentors within their discipline.*
- *Students are actively introduced and engaged in research (specifically in biology) beginning their freshman year. They begin in BIOL199 Freshman Seminar and continue through BIOL299 Sophomore Seminar, BIOL399 Junior Seminar, and BIOL499 Senior Seminar.*
- *The school also engage students through social events where students and faculty can interact with each other.*

Resources (CC 5.A and CC 5.C).

11. Describe how the School allocates resources to adequately support the mission. Include explanations of faculty/staff, fiscal, and infrastructure allocations. For example, describe the process used to ensure that each faculty member or instructor in the program is qualified to teach the courses they are assigned, as consistent with HLC guidelines. (https://www.hlcommission.org/Publications/determining-qualified-faculty.html)

Resources are allocated to programs/courses based on the approved budget for the school. Specifically, budget requests for the school include funding from course fees that are allocated to support the academic activities associated with courses and program fees that are allocated to support the purchases of program specific equipment relevant to the programs. The fees are reviewed and assessed annually by the school faculty to ensure that the fees are adequately addressing the needs of the programs/courses. Requests for fee adjustments are submitted to the administration for consideration in the spring semester of each year. The school maintains a priority list of equipment maintenance and replacement that is used to help with the budgeting request for funding generated by the program fees.

Faculty within the disciplines determine the teaching qualifications that are required to teach the courses within the specific programs, in accordance with the HLC guidelines. Faculty who meet these qualifications can then be assigned to the specific courses.

12. Explain how the School ensures that the curriculum for each program is current. For example, evidence may include specialized program accreditation, advisory boards, input from industry, discipline standards, previous School reviews or reports, etc.

Curriculum relevancy and currency are determined by the faculty within the disciplines. Program assessment is done by the faculty and documented in the Nuventive Improve software that is maintained by the university. Several programs are accredited through outside agencies that also ensure each program is current and relevant. Those programs include Medical Laboratory Science (MLS), accredited by National Accrediting Agency for Clinical Laboratory Sciences, and the Chemistry, Biochemistry, and Forensic Chemistry programs, which are approved by the American Chemical Society. The latest self-study for the chemistry accredited programs and the site visit report for the MLS program are attached to this document. The MLS program also has an advisory board which provides input for the program. The biology and chemistry programs stay current with input from medical schools, including the Early Assurance Program through Michigan State University. Faculty also regularly review curriculum requirements for graduate schools and for professional programs in pharmacy, physician assistant, veterinary, dental and optometry schools.

Appendix Cover Sheet

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Send email with supporting documentation to: TRACDAT@Issu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**Science and Medicine**
Document Title (if attached) or Filename (if emailed):	Most recent report, findings and recommendations from the National Accrediting Agency for Clinical Laboratory Sciences
This documentation is relevant to Question number:	**5**
Briefly summarize the content of the file and its value as evidence supporting program review:	**In May 2018, the Medical Laboratory Science program received its initial accreditation from NAACLS.**

NAACLS

National Accrediting Agency
for Clinical Laboratory Sciences

May 9, 2018

Peter Mitchell, PhD
President
Lake Superior State University
Office of the President
650 W. Easterday Avenue
Sault Ste. Marie, MI 49783

Dear President Mitchell,

Enclosed is the NAACLS Board of Directors' official accreditation award for your Medical Laboratory Scientist program from the April 26, 2018 meeting.

The Board of Directors' award is based on the initial accreditation review process that included a site visit of your program during fall of 2017.

Accreditation for your program will continue until April 30, 2023. As a result, your program will commence renewal of accreditation with submission of the Self-Study Report on April 1, 2022 and the scheduling of a site visit during fall of 2022. We provide this information to assist you in your program's administrative and financial planning.

This letter and the accompanying award represent formal accreditation by NAACLS. The NAACLS Certificate of Accreditation will be forwarded to the Program Director.

Sincerely,

William H. Hunt, MBA, MLS(ASCP)^{cm}
President, NAACLS Board of Directors

cc: Martha Hutchens, PhD, MLS(ASCP)^{cm}, Program Director
Donna Fiebelkorn, PhD, Dean, College of Natural and Mathematical Sciences

5600 N. River Road, Suite 720 Rosemont, IL 60018
773.714.8880, 773.714.8886 (fax), info@naacls.org
www.naacls.org

NAACLS BOARD OF DIRECTORS' ACCREDITATION AWARD

The Medical Laboratory Scientist Program of **Lake Superior State University** in **Sault Ste. Marie, Michigan,** is awarded **Initial Accreditation for five (5) years.**

An Initial Progress Report is due by **April 1, 2020**. The Initial Progress Report must document compliance with the following Standards and be submitted in triplicate to NAACLS by the due date.

Standard II.B **Outcome Measures**

A review of the results of the following outcomes measures from at least the last three active years must be documented, analyzed and used in program assessment and continuous quality improvement of the program to include an annual submission to NAACLS. If outcome measure(s) does/do not meet the stated NAACLS approved benchmarks (see Standards Compliance Guide), then an analysis and action plan must be submitted to correct the deficiency (ies).

1. External certification results
2. Graduation rates
3. Placement rates (i.e., employment positions in the field of study or pursuit of further education)
4. Attrition rates
5. Other (optional): such as results of capstone projects, faculty feedback, exit or final examinations, exit interviews with graduates, student and graduate professional leadership, impact of the program on local and regional healthcare, etc.

Standard II.C **Program Assessment and Modification**

The results of program outcomes measures and assessment must include findings from graduate and employer feedback and be:

1. Reflected in ongoing curriculum development, resource acquisition/allocation, and program modification.

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www.naacls.org

2. Analyzed to demonstrate the effectiveness of any changes implemented.

Failure to submit the required report by the due date may result in Administrative Probation.

Martha Hutchens, PhD, MLS(ASCP)^{cm} is recognized as Program Director.

William H. Hunt, MBA, MLS(ASCP)^{cm}
President, NAACLS Board of Directors

Dianne M. Cearlock, PhD, MT(ASCP)
Chief Executive Officer

April 26, 2018

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School:	**Science and Medicine**
Document Title (if attached) or Filename (if emailed):	Most recent report, findings and recommendations from the American Chemistry Society for chemistry programs.
This documentation is relevant to Question number:	**5**
Briefly summarize the content of the file and its value as evidence supporting program review:	**In August 2016, the chemistry programs received "continuing approval" status from the ACS.**

ACS Chemistry for Life

American Chemical Society

COMMITTEE ON PROFESSIONAL TRAINING
1155 Sixteenth Street, N.W.
Washington, DC 20036

Fax: (202) 872-6066
Email: cpt@acs.org
Web: www.acs.org/cpt

Cathy A. Nelson, *Secretary* (202) 872-4589

25 August 2016

Dr. Derek Wright, Chair
School of Physical Sciences
Lake Superior State University
650 West Easterday Avenue
Sault Ste. Marie, MI 49783

Dear Dr. Wright:

The Committee on Professional Training reviewed the department's 2015 periodic report. Based on the information available, the Committee concluded that the chemistry program meets all of the requirements in the ACS Guidelines and agreed to **continue approval.**

The Committee commended the administration for providing the department with an excellent range of improvements, including the additional staff and lab space, the substantial funding for instrument maintenance and repair, and the increased funds for faculty development. The number of faculty publications is very impressive for a school of this size. The curricular revision activities are also noteworthy. The biochemistry classroom and lab courses are excellent, and the equipment is state-of-the-art. The quality of the student research reports was characterized as very good.

The Committee made the following suggestion for the continued development of the chemistry program.

Tracking graduates. According to Item 1.4, the career paths were unknown for one-fourth of the graduates during the five years covered in the report. The Committee encourages the department to improve efforts to track the outcomes of students following graduation. Strong connections to alumni are an invaluable source of feedback for program improvement, employment opportunities for new graduates, and financial assistance.

The program's next periodic report will be due in **2021**. Please do not hesitate to contact me if you have any questions about the information in this letter or the expectations for ACS-approved programs.

Sincerely,

Cathy A. Nelson

Cathy A. Nelson
Secretary
Committee on Professional Training

CAN/dth/daa

c: Dr. Thomas C. Pleger, President

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	**School of Science and Medicine**
Document Title (if attached) or Filename (if emailed):	**School: Planning Unit Four Column Report**
This documentation is relevant to Question number:	**7**
Briefly summarize the content of the file and its value as evidence supporting program review:	**The 4 column assessment report for the School of Science and Medicine assesses the school's support of the CAFÉ goals for the university.**

Assessment: Planning Unit Four Column

School: Planning - Science and Medicine

Assessment Contact: Dr. Barbara Keller, Chair
Mission Statement: Our mission is to produce exceptional graduates through emphasis on rigorous applied programs, hands-on experiences, and interaction with highly qualified faculty members who are centered on student success.
Our vision is to inspire and prepare students to positively change the Upper Great Lakes Region and beyond through science.

Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Culture - Cultivate an environment within the School of Science and Medicine supportive of collaboration and inclusion for students, faculty and staff in all fields of study. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** C1. We cultivate an environment of inclusion where all members treat others with dignity and respect.	Collaborations of school faculty and students within and outside of the university will be listed.		
	Students will be surveyed for their perceptions of the School and College culture	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes 100% of students in the school who were surveyed responded positively to the survey question "How would you rate yourself in terms of your proficiency in the areas of professionalism/work ethic?" with 62.2% reporting a rating of 5 and 37.8% reporting a rating of 4 (on a scale where 1 = low and 5 = high). (09/27/2018) **Related Documents:** SSM only Copy of LSSU Graduate Survey (Responses) 8-22-18.xlsx CoSE Graduate Survey results 2018-08-02-1.docx	**Use of Result:** Goal met, reassess next year. (09/27/2018)
		Finding Reporting Year: 2018-2019 **Goal met:** Yes COSE student graduates were surveyed during the summer of 2018. Overall greater than 60% of the graduates expressed satisfaction with their experience at LSSU and their post graduate successes. (09/26/2018) **Related Documents:**	

Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
		CoSE Graduate Survey results 2018-08-02-1.docx SSM only Copy of LSSU Graduate Survey (Responses) 8-22-18.xlsx	
Academics - Promote faculty-student interaction, high-quality classroom instruction, hands-on research opportunities and advising. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** A1. We will cultivate continuous academic and co-curricular improvement to provide relevant programs and support services.	Reports on student senior research projects will noted which may include a list of the project titles, abstracts from the student presentations, pictures of students at the research symposium.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 48 Biology students completed senior research projects (16 students fall 2017 and 32 spring 2018) during the academic year. (10/02/2018) **Related Documents:** 499 Abstract 2017 Fall.docx 2018 Biol 499 Senior Research Seminar Abstract.docx	**Use of Result:** Goal met. Reassess next year. (10/02/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes 12 chemistry/biochemistry/forensic chemistry students, 3 students during the fall 2017 semester and 9 during the spring 2018 semester, successfully completed a capstone senior research project. (10/01/2018) **Related Documents:** CHEM 499 Abstracts fall 2017.docx CHEM 499 Abstracts spring 2018.docx	**Use of Result:** Goal met, reassess next year. (10/01/2018)
	Advising reports will be collected from the faculty.		
	A list of faculty and student grants and research will be generated annually.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Faculty in the school have received 34 research grants between 2011 and 2018, totaling $11,055,629. (10/10/2018) **Related Documents:** School Grants.xlsx	**Use of Result:** Goal met. Reassess annually. (10/10/2018)
	Students responses/feedback from a survey will be reported.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes Results from the 2018 LSSU Graduate Survey response for Biology students (19) reported that 47% had entered graduate school, 26% were employed in their discipline, 11% were employed outside of their discipline, 11% were unemployed, and 5% were doing internships within their	

Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
		discipline. (10/01/2018)	
		Finding Reporting Year: 2018-2019 **Goal met:** Yes 100 % of students responded positively to the the survey question "To what extent did your university experience help to build critical thinking skills?" with 33.3% reporting 5, 48.9% reporting 4 and 17.8% reporting 3 in a rating system where 5 equates to high and 1 equates to low. (09/27/2018) **Related Documents:** LSSU Graduate Survey Questions.pdf SSM only Copy of LSSU Graduate Survey (Responses) 8-22-18.xlsx	**Use of Result:** Goal met, reassess next year. (09/27/2018)
	Examples of teaching innovations will be collected.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes Dr. Thu Nguyen was awarded $3000 by the LSSU FCT Funding Innovations in Teaching to develop new laboratories for the general chemistry sequence that enhance student learning. The new laboratories are being implemented the 2018-19 academic year. (10/01/2018)	
Finance - Promote transparent fiscal responsibility in all budgetary processes including the collection and allocation of course and program fees to meet the needs of our students and programs. **Goal Status:** Active **Strategic Plan Outcome(s) addressed:** F2. We will cultivate data-informed budgetary processes that are open, transparent, and in alignment with institutional priorities.	School spending will remain within the budget.		
	The School will build a prioritization list for equipment replacements and purchases.	**Finding Reporting Year:** 2018-2019 **Goal met:** Yes The prioritization list of equipment for the 2018-19 fiscal year for the school was developed. (10/02/2018) **Related Documents:** 2018 - Prioritized instrument and equipment list.docx	**Use of Result:** Goal met, reevaluate next year. (10/02/2018)
Enrollment - Improve recruitment and retention for students enrolled in programs offered by the School of Science and Medicine	Outreach programs with K-12, community colleges, tribal partners, and other organizations will be reported.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Faculty in the school have been involved with 27 outreach activities (see related document) with pre-K-12, community	**Use of Result:** Goal met. Reassess annually. (10/10/2018)

Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
Goal Status: Active **Strategic Plan Outcome(s)** addressed: E3. We will cultivate continuous improvement of the student experience through data-informed decision making and student input.	School retention will be consistent with or better than the overall university retention.	colleges, and tribal partners. (10/10/2018) **Related Documents:** Outreach 2017-2018.docx	
	The development and use of marketing materials, by ourselves and in collaboration with the University marketing team will be reported.		

PART 2: Degree-Level Review

Degree Program: B. S. Biochemistry

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

1. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

2. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

The American Chemical Society accreditation is the highest standard accreditation for chemistry programs in the world. Our accreditation requires that students have training in all areas of chemistry. Based on our assessment, we made the following changes to meet current standards:

1. *Curriculum for the program was augmented to require physical chemistry courses, such that the students have proper training in all areas of chemistry.*
2. *Our Organic Chemistry II course was changed from a 200 level to a 300 level course to increase the level of student learning outcomes in the course.*
3. *The degree was updated to include CHEM 310 (Applied Spectroscopy) for all chemistry majors.*
4. *We sought funding to increase our spectroscopic capabilities for teaching and student and faculty research, resulting in the acquisition of new MP-AES, IR, IC, qPCR, thermocycler, and NMR instruments.*
5. *We are currently in discussions to alter our seminar courses to better prepare students for their research experiences, their professional presentations, and their careers.*

Quality, Resources and Support (CC 3.A)

3. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

The biochemistry B.S. program is ACS approved and meets program level and course level outcomes that are appropriate for this professional training. The guidelines may be found at the following:

https://www.acs.org/content/dam/acsorg/about/governance/committees/training/2015-acs-guidelines-for-bachelors-degree-programs.pdf

The degree audit is attached to this report.

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

4. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

All students complete a capstone senior project, which includes faculty guided research beginning in their junior year or earlier, culminating in professionally presented research products (poster session, formal oral presentation, formal report) their senior year. Many research projects are externally grant funded, providing students opportunities to present at national conferences and gain authorship on peer reviewed publications.

A list of student research abstracts and faculty-student research manuscripts are attached to this report.

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Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	
Document Title (if attached) or Filename (if emailed):	
This documentation is relevant to Question number:	
Briefly summarize the content of the file and its value as evidence supporting program review:	

Assessment: Program Four Column

Biochemistry - 22oct2018 Assessment_ Program Four Column

Program (CoSE) - Biochemistry Preprofessional BS

Mission Statement: The mission of the BS Chemistry Preprofessional degree is to prepare effective, knowledgeable and professional leaders for medicine, pharmacy, dentistry and veterinary medicine.
Assessment Contact: Dr. Steven Johnson
Program Notes: Formerly a B.A. Chemistry/Preprofessional

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Knowledge & Skills - The BS Biochemistry student will demonstrate proficiency in their discipline. **Goal Status:** Active **Start Date:** 01/22/2016 **Goal Level (Bloom/Webb):** Low-Level (Understanding/Remembering) [Bloom]	Competence in the use of chemical instrumentation and laboratory skills including safe chemical practices **Criteria Target:** 100 % of students will complete 400 laboratory hours and successfully pass CHEM332 **High Impact Program Practices 1:** Collaborative Assignments, Projects	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students successfully passed CHEM332. (08/20/2018)	**Use of Result:** Goal met. Re-assess annually. (08/22/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students successfully passed CHEM332. (05/01/2017)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
	Students will demonstrate communication and information retrieval skills **Criteria Target:** 100% of students will successfully complete CHEM495 and CHEM499 **High Impact Program Practices 1:** Capstone Course(s), Projects **High Impact Program Practices 2:** Writing-Intensive Course(s)	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students successfully completed CHEM499. 100% of students successfully completed CHEM495. (08/23/2018) **Related Documents:** Chem & Envi Science Senior Thesis Presentations .pdf	**Use of Result:** Goal met- continue to re-evaluate annually. (08/23/2018)
	Students will successfully complete CHEM351, CHEM452, CHEM495, CHEM499 **Criteria Target:** 100 % of students will successfully pass CHEM351, CHEM452, CHEM495, CHEM499	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students successfully passed CHEM351, CHEM452, CHEM495, and CHEM499. (08/23/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
		Finding Reporting Year: 2016-2017	**Use of Result:** Goal met. Reassess

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	High Impact Program Practices 1: Capstone Course(s), Projects **High Impact Program Practices 2:** Undergraduate Research	**Goal met:** Yes 100 % of students successfully passed CHEM351, CHEM452, CHEM495, and CHEM499. (05/01/2017)	annually. (05/01/2017)
Employability and Readiness for Graduate and Professional Study - The Pre-professional BS Biochemistry graduate will demonstrate readiness for employment as a chemist, science technician, or chemical technician at the baccalaureate level or graduate and professional level study. **Goal Status:** Active **Institutional Learning:** ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal.	**Indirect - Survey, including faculty, supervisors, employers -** Graduate/Alumni Survey **Criteria Target:** Greater than 50% of students will express satisfaction with their preparedness for professional employment or graduate/professional study.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Greater than 50% of student self reported as satisfied with their preparedness. (08/23/2018) **Related Documents:** LSSU Graduate Survey Chemistry.xlsx	**Use of Result:** Goal met- reassess annually. (08/23/2018)
	Graduates will gain entry into graduate and professional programs. **Criteria Target:** Graduates will gain entry into graduate and professional programs.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 4 students were accepted into graduate/professional programs. (08/23/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 7 students were admitted into graduate/professional programs. (05/01/2017)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
Scholarship - The BS Biochemistry student will engage in university-supported faculty led research in chemistry **Goal Status:** Active	**Direct - Laboratory, Clinical, Skill/Competency Assessments -** 100% of students will complete a senior research project. **High Impact Program Practices 2:** Undergraduate Research	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students presented results for their senior research projects at the Symposium and Senior Research Presentations. (04/30/2018) **Related Documents:** Chem & Envi Science Senior Thesis Presentations .pdf	**Use of Result:** Goal met. Reassess annually. (08/23/2018)

2015 Periodic Report
to the
ACS Committee on Professional Training

Please consult the ACS Guidelines (http://www.acs.org/cpt) before completing this report. The information contained in this report should pertain only to your undergraduate program. To facilitate committee review, all responses must be provided on this form. Extra pages for the tables are available under the Templates tab on CPRS.

Name of Institution: Lake Superior State University

City, State, and Zip Code: 650 W. Easterday Ave., Sault Sainte Marie MI 49783

Report Prepared by (e.g., Dr. Mary Smith or Juan Ruiz): Dr. Derek D. Wright
E-mail Address: dwright1@lssu.edu
Phone Number: (906) 635-2628

Current Chemistry Department Chair
Name: Dr. Derek D. Wright
Title: Associate Professor

Name of Department: School of Physical Sciences

Section 1

1.1 Degrees Offered in Chemistry (check those offered)

- Bachelor's ☒
- Master's ☐
- Ph.D. ☐

1.2 Number of Calendar Weeks per Term (not counting final exams)

- Semester: 14
- Quarter:
- 4-1-4:
- Other:

1.3 Provide the number of students in the current (most recently completed) academic year:

Entire Campus	2432
Undergraduates	2432
Chemistry Seniors	15
Sum of enrollments in all undergraduate chemistry courses	747

1.4 Provide the number of bachelor's-degree graduates during the past six years who went on to:

Graduate School in the Chemical Sciences	18
Medical and other Professional Schools	5
Industry	14
Teaching	0
Other/Unknown	14

Section 2: Institutional Environment

2.1 Is the institution accredited by a regional accrediting association? Yes ☒ No ☐
Name of Accrediting Association Higher Learning Commission

2.2 Is the chemistry department organized as an independent administrative unit? Yes ☐ No ☒

a. If no, how is the department or program administered and to whom does the department administrator report?

Chemistry is housed within the School of Physical Sciences, which also includes programs in the Environmnetal Sciences, and Geology. The School has a Chair, who reports to the Dean of Natural and Mathmatical Sciences.

b. If no, who controls budgetary, personnel, and teaching decisions for the chemistry program, and how are chemistry faculty involved?

Budgetary, some personnel, and course scheduling decisions are made primarily by the Chair of Physical Sciences, through close consultation with the faculty. These decisions are approved by the Dean.

2.3 Check the Minimum Salary for each Rank of Chemistry Faculty (Nine Months)

Minimum Salary	Professor	Associate Professor	Assistant Professor	Long-term, permanent
Below $51K	☐	☒	☒	☐
$51 - $60K	☒	☐	☐	☐
$61 - $70K	☐	☐	☐	☐
$71 - $80K	☐	☐	☐	☐
$81 - $90K	☐	☐	☐	☐
Over $90K	☐	☐	☐	☐

2.4 Chemistry Expenditures (rough estimates – 2 significant figures):
If your expenditures are over $60,000 per year, excluding internal and external grants, salaries, and library budget, check here ☒ and go to Item 2.5.

	Current	Annual Average Over the Past Five Years
Operating Expenditures Exclusive of Salaries		
Instrument Maintenance and Repair		
Student and Faculty Travel		
Grants		

2.5 Describe whether the level of institutional support allows the department to meet its teaching, infrastructure, and faculty development needs.

The Institution supports 8 faculty & 2 full time staff for lab prep and instrumentation maintenance. Our physical facilities are located in Crawford hall, which was renovated in the year 200. We have 5 instructional labs, one shared instrumentation room, 3 shared research labs dedicated primarily to chemistry instruction and research, and a central stockroom. In addition to the base budget and course fees which generate ~$85,000 annually, the Dean has a discretionary fund for instrument maintenace and replacement, which typically invests ~$40,000 annually in Chemistry equipment. Additional investments typically ~$30,000 annually are made using revenue generated by the Environmental Analysis Lab, a contract lab operated by the School.

Section 3: Faculty and Staff

3.1 Number of Chemistry Faculty in the Spring 2015 Academic Term **(If you have no faculty in a particular category, record a "0").** Please be sure the totals in the top row (Full-time/Part-time totals) add up below.

Faculty	Total Faculty	With Ph.D.	Male	Female	African American	Native American	Asian American	Hispa Ameri
Permanent total	8	8	6	2	0	0	0	0
Full-time	8	8	6	2	0	0	0	0
Tenured	4	4	3	1	0	0	0	0
Pre-tenured	4	4	3	1	0	0	0	0
Long-term, non-tenure track	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0
Tenured	0	0	0	0	0	0	0	0
Pre-tenured	0	0	0	0	0	0	0	0
Long-term, non-tenure track	0	0	0	0	0	0	0	0
Temporary total	0	0	0	0	0	0	0	0
Full-time	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0

3.2 Number of Instructional Staff (Do not include faculty listed in Item 3.1 or Teaching Assistants. **If you have no instructional staff in a particular category, record a "0".**)

Instructional Staff	Total Staff	With Ph.D.	Male	Female	African American	Native American	Asian American	Hispa Ameri
Long-term*	3	2	2	1	0	0	1	0
Full-time	0	0	0	0	0	0	0	0
Part-time	3	2	2	1	0	0	1	0
Temporary	0	0	0	0	0	0	0	0
Full-time	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0

* Employed for three years or more or expectation of employment for at least three years

3.3 The ACS is concerned about potential overreliance on temporary (part-time and full-time) faculty and instructional staff. If the total number of temporary (full- or part-time) faculty and instructional staff exceeds 50% of the number of permanent faculty and long-term instructional staff listed in items above (3.1 and 3.2 explain their roles in student instruction.

3.4 a. Briefly describe your activities (especially successes) in expanding faculty diversity over the last five years.

Consistant with state and federal laws, LSSU is an equal opportunity employer. All job postings include language encouraging diverse applicants, and positions are posted in the Chronicle of Higher Education, Higher Ed Jobs, and the LSSU Website. One female faculty member in Chemistry was hired in the last 5 years. Two other female faculty, one hispanic, were recently hired in Physics and Env. Sci

b. Describe any attributes of diversity among your faculty not captured in Items 3.1 and 3.2.

None

3.5 a. Number of Support Staff:

Secretarial	0.5
Stockroom	2
Instrument Technicians	
Other	

b. Comment on the adequacy of support staff:

Our suppoert staff consists of one Secretary (shared with Biology) and two full time staff members, a laboratory manager and a technician. The labopratory manager is responsible for managing the stockroom, ordering supplies, and ensureing that instrumentation is in working order. The Technician assists the laboratory manager in the stockroom and with instument maintenance and repair. We also employ 10-15 students 6-8 hrs per week each semster to assist with lab prep. This staffing arrangement has proven to be adequate to support our program.

3.6 Describe the professional development opportunities (including sabbaticals) that are available to chemistry faculty and instructional staff.

The Univeristy provides $1000 annually to faculty which can be used for professional development activities at their discretion. Each acadmic year, 3 semesters of paid sabattical are available to the Full time Faculty (~120 faculty). Two of the current Chemistry faculty have received a full year sabattical in the past 7 years. Additional professional development opportunities include support for seminar speakers and conference attendance through units such as the Faculty Center for Teaching, and the LSSU Foundation.

3.7 Report the number of chemistry faculty and instructional staff who have taken a sabbatical or professional leave in the last six years.

Requested 1
Granted 1

3.8 Teaching Contact Hours for 2014-2015 Academic Year (Classroom and Lab)
Please provide the minimum and maximum numbers that occurred during this academic year. **The ranges reported here should match the numbers reported in Table 3.1.**

a. Contact Hours/week for Chemistry Faculty (exclusive of research):
Range from 10 to 16 ; Average 14.3

b. Contact Hours/week for Instructional Staff:
Range from 2 to 6 ; Average 4

c. If you need to explain how contact hours are counted or if there is a special situation, for example, for online instruction please explain:

d. Are maximum and/or minimum teaching loads established as an institutional policy?
Yes ☒ No ☐

If yes, explain briefly:
Teaching loads are established under the Faculty Association agreement with a minimum of 12 contract hours per semester. One contract hour is equal to one hour of lecture instruction, while one hour of lab instruction is equal to 0.66 contract hours. Teaching load (release time) is awarded to the School Chair (3 hrs per semster) and coordinaters of multiple lab sections. The maximum load is 32 hrs/year

3.9 a. Do you use undergraduate student teaching assistants? Yes ☐ No ☒

If yes, answer items b. and c.

b. Describe the formal instruction and assistance in laboratory and/or classroom teaching provided to undergraduate student teaching assistants.

Table 3.1 – Teaching Contact Hours

Provide the **actual contact hours** per week for each individual involved in undergraduate instruction for the 2014-2015 academic year. List one faculty member per row and enter as many faculty per page as possible. List non-tenure-track faculty, temporary faculty, and instructional staff and **identify them with the key below**. Do not include graduate teaching assistants. If the average number of contact hours for your department is less than 12 contact hours per week, complete Table 3.1 for those individuals with 12 or greater contact hours per week. Additional copies of this table are available under the Template tab on CPRS.

	Fall Semester/1st Quarter 2014				Spring Semester/2nd Quarter 2015		
Faculty Member (list according to rank)	**Course Number and Title**	**1***	**2***	**3***	**Course Number and Title**	**1***	**2***
Curie, Marie (Professor)	CHEM112 – Gen Chem I CHEM 257 – O. Chem I CHEM 358 – O.Chem Lab (2 sections)	3 3 0	0 3 4	13	CHEM257 – Analytical Chemistry CHEM360 – O. Chem II	3 3	3 3
Iretski, Alexei (Professor)	CHEM115 - Gen Chem CHEM362 - P Chem 2 CHEM363 - P Chem Lab	4 3 0	4 0 3	14	CHEM115 - Gen Chem CHEM116 - Intro P Chem CHEM261 - Inorganic Chem CHEM461/462 - Adv Inorg Che	4 0 3 3	0 3 0 3
Werner, R. Marshall (Professor)	CHEM109 - App Chem Lab CHEM110 - App Org & Biochem CHEM351 - Biochem 1	0 3 3	3 0 6	15	CHEM110 - App Org & Biochem CHEM 115 - Gen Chem CXHEM452 - Adv Biochem	3 0 2	4 2 4
Wright, Derek (Associate Professor)	NSCI103 - Env Sci NSCI104 - Env Sci Lab EVRN317 - Env Health App	3 0 3	0 2 3	11	NSCI103 - Env Sci NSCI104 - Env Sci Lab NSCI116 - Oceanography	3 0 3	0 2 2
Heth, Christopher (Assistant Professor)	CHEM116 - Intro P Chem lab CHEM231 - Quant Analysis CHEM499 - Senior Sem HONR101 - Honors Sem 1	0 3 1 3	3 6 0 0	16	CHEM332 - Instrumental Anal CHEM445 - Forensic Sci CHEM499 - Senior Thesis	3 1 1	9 0 0
Johnson, Steven (Assistant Professor)	NSCI110 - Intro to Forensics CHEM115 - Gen Chem CHEM116 - Intro P Chem	3 4 4	2 2 0	15	CHEM116 - Intro P Chem CHEM445 - Forensic Sci	4 2	6 3
Kelly, Megan (Assistant Professor)	CHEM108 - Applied Chem EVRN425 - Env Sysytems NSCI104 - Env Sci lab USEM101 - Univ. Seminar 1	3 3 0 1	3 3 2 0	15	CHEM108 - Applied Chem CHEM115 - Gen Chem CHEM116 - Intro P Chem NSCI104 - Env Sci lab	3 0 0 0	3 2 3 4
Mosey, R. Adam (Assistant Professor)	CHEM110 - App Org & Biochem CHEM225 - Organic Chem 1 HONR302 - Honors Seminar	0 3 3	2 6 0	14	CHEM116 - Intro P chem CHEM226 - Organic Chem 2	0 3	3 9
Blanchard, Roger @ (Adjunct Instructor)	CHEM110 - App Org & Biochem CHEM115 - General Chem	0 0	2 2	4			
Nguyen-Mosey, Thu @ (Adjunct Instructor)	CHEM115 - General Chem CHEM225 - Organic Chem 1	0 0	2 3	5	CHEM225 - Organic Chem 1	3	3
Southwell, Benjamin (Adjunct Instructor)	CHEM115 - General Chem	0	2	2	CHEM261 - Inorganic Chem	0	3

*1 Number of class hours scheduled per week.

*2 Number of contact hours of lab per week.

*3 Total of columns 1 and 2 for a grand total for each individual.

\# Non-tenure faculty

@ Temporary faculty and instructional staf

\+ Long-term instructional staff

Section 4: Infrastructure

4.1 Comment on the adequacy and condition of your department's instruments and lab apparatus to meet your program's teaching and research needs. Describe the arrangements for repair and maintenance of instruments.

Instrumentation maintenance and repair is primarily conducted and coordinated by the science lab manager and the technician, with occasional assistance from faculty. Manufacturer service contracts are also utilized in some instances.

4.2 Do you rely on off-site instrumentation to meet your department's research needs? Yes ☐ No ☒

If yes, please describe the arrangement:

4.3 Comment on the adequacy of the facilities and space available for the undergraduate chemistry program.

We operate 5 instructional labs, 3 shared research labs, and a core instrumentation lab all dedicated to the undergraduate chemistry curriculum. We also share a computer lab which provides access to computational chemistry software (Spartan & Spartan Student). These facilites are properly supplied with safety equpiment including exhaust hoods, gas/vacuum etc., and are adequate to support our program.

4.4 a. Indicate the number of chemistry journals to which students have immediate institutional access on your campus. **If students have access to 30 or fewer chemistry journals, complete Table 4.2.**

30 or fewer ☐ More than 30 ☒

b. Do your students and faculty have access to journals that are not available on campus through interlibrary loan? Yes ☒ No ☐

c. What types of access do undergraduate students and faculty have to chemical information databases on your campus? (Check all that apply.)

Online through ChemSpider	☒
Online through SciFinder	☒
Online through STN	☐
Online through Web of Science	☐
Other access	☐

Specify _____

4.5 What is the maximum number of students in a laboratory section who are directly supervised per faculty member, instructional staff member, or teaching assistant? 24

Table 4.1 – Instrumentation and Specialized Laboratory Apparatus

If you have more than one particular instrument, please list up to two. **Only report functioning instrumentation that is used by undergraduate students.** If your department has more than one of a particular instrument type, please list the two newest.

Instrument/Apparatus	Used by Undergraduates		Year Acquired	Manufacturer and Mod
	In Chemistry Course Work	In Research		
NMR spectrometer(s)	☒	☒	2006	Anasazi EM 360
	☐	☐		
Optical Molecular Spectroscopy	☒	☒		
IR spectrometer(s)	☒	☒	2009	Perkin Elmer Spectrum
	☐	☐		
UV-Vis spectrometer(s)	☒	☒	2010	Mol. Dev. Spectro Max
	☒	☒	2009	Perkin Elmer Lamba 35
Other	☒	☒	2014	Shimadzu BioSpec-nano
Optical Atomic Spectroscopy	☒	☒		
Atomic absorption/emission	☒	☒	2014	Agilent 4200 MP-AES
	☒	☐	2000	Perkin Elmer AAnylist
Other	☐	☐		
Mass Spectrometry	☒	☒		
Mass spectrometer(s)	☒	☒	2003	Agilent 7500a ICP-MS
	☐	☐		
GC-Mass spectrometer(s)	☒	☒	2004	Agilent 6890N Series/5
	☒	☒	2001	HP 5890 Series II/5971
Other	☐	☐		
Chromatography and separations	☒	☒		
Gas chromatograph(s)	☒	☒	2000	Agilent 6890 GC/FID (3
	☒	☒	2000	Agilent 6890 GC/TCD
Liquid chromatograph(s)	☒	☒	2009	Agilent 1100 PDA (4)
	☒	☒	2004	Waters 2695 PDA/Fluore
Gel electrophoresis	☒	☒	2011	CBS Sci. MGU-102T Hori
	☒	☒	2015	Biorad Mini Protean Ve
Other	☒	☒	2015	Metrohm 930 Ion Chroma
Electrochemistry	☒	☒		
Electrochemical Instrumentation	☒	☒	2014	BASi Epsilon
	☐	☐		
Other	☐	☐		
Other	☒	☒		
Radiochemistry (including counting equipment and sources)	☐	☐		
	☐	☐		
Thermal analysis equipment	☐	☐		
	☐	☐		
Schlenklines and dry box apparatus	☒	☒	2014	2 Schlenklines
	☐	☐		
Imaging microscopy	☒	☒	1993	Jeol 6100 SEM-EDS w/La
	☐	☐		
Other	☒	☒	2010	TS Legend XFR Centrifu
Additional Instruments (over $10,000 in cost):				
	☒	☒	2015	AB StepOne Plus qPCR
	☐	☐		

Table 4.2 – Journal List

Indicate the current chemistry-related periodicals to which students have print or online access. Please use the blanks provided if you have additional journals to list.

General Content

- ☐ Accounts of Chemical Research
- ☐ ACS Central Science
- ☐ Angewandte Chemie Intl Edition in English
- ☐ Chemical Communications
- ☐ Chemical Science
- ☐ Chemistry – A European Journal
- ☐ Chemistry Letters
- ☐ Journal of the American Chemical Society
- ☐ Nature, Nature Chemistry
- ☐ New Journal of Chemistry
- ☐ Proceedings of the National Academy of Science
- ☐ Science

Topical titles

- ☐ ACS Chemical Biology
- ☐ ACS Chemical Neuroscience
- ☐ ACS Medicinal Chemistry Letters
- ☐ ACS Nano
- ☐ Advanced Functional Materials
- ☐ Advances in Heterocyclic Chemistry
- ☐ Advanced Materials
- ☐ Advanced Synthesis and Catalysis
- ☐ Advances in Protein Chemistry
- ☐ Analyst
- ☐ Analytica Chimica Acta
- ☐ Analytical and Bioanalytical Chemistry
- ☐ Analytical Biochemistry
- ☐ Analytical Chemistry
- ☐ Applied Catalysis A
- ☐ Applied Spectroscopy
- ☐ Beilstein Journal of Organic Chemistry
- ☐ Biochemical Journal
- ☐ Biochemistry
- ☐ Biochimica et Biophysica Acta
- ☐ Bioconjugate Chemistry
- ☐ Biomacromolecules
- ☐ Biomaterials
- ☐ Bioorganic Chemistry
- ☐ Bioorganic and Medicinal Chemistry Letters
- ☐ Chemical Education: Research and Practice
- ☐ Chemical Educator
- ☐ Chemistry of Materials
- ☐ ChemPhysChem
- ☐ Chemical Physics Letters
- ☐ Chirality
- ☐ Combinatorial Chemistry and High Throughput Screening
- ☐ Current Opinion in Chemical Biology
- ☐ Dalton Transactions
- ☐ Electrophoresis
- ☐ Environmental Science and Technology
- ☐ European Journal of Inorganic Chemistry
- ☐ European Journal of Organic Chemistry
- ☐ FEBS Journal
- ☐ Green Chemistry
- ☐ Heterocycles
- ☐ Inorganic Chemistry
- ☐ Journal of the American Society for Mass Spectrometry
- ☐ Journal of Applied Polymer Science
- ☐ Journal of Bacteriology
- ☐ Journal of Biological Chemistry
- ☐ Journal of Biological Inorganic Chemistry
- ☐ Journal of Catalysis
- ☐ Journal of Chemical Ecology
- ☐ Journal of Chemical Education
- ☐ Journal of Chemical Information and Modeling
- ☐ Journal of Chemical Physics
- ☐ Journal of Chemical Theory and Computation
- ☐ Journal of Chromatography A, B
- ☐ Journal of Medicinal Chemistry
- ☐ Journal of Molecular Biology
- ☐ Journal of Organic Chemistry
- ☐ Journal of Physical Chemistry A, B, C
- ☐ Journal of Physical Chemistry Letters
- ☐ Journal of Polymer Science Part A
- ☐ Journal of Proteome Research
- ☐ Langmuir
- ☐ Macromolecules
- ☐ Molecular Cell
- ☐ Nanoletters
- ☐ Nature Chemical Biology, Structural and Molecular Biology
- ☐ Nucleic Acids Research
- ☐ Organic and Biomolecular Chemistry
- ☐ Organic Letters
- ☐ Organometallics
- ☐ Physical Chemistry Chemical Physics
- ☐ PLOS One
- ☐ Polymer
- ☐ Polymer Degradation and Stability
- ☐ Supramolecular Chemistry
- ☐ Synlett
- ☐ Synthesis
- ☐ Tetrahedron
- ☐ Tetrahedron Letters

4.6 a. Are the following laboratory facilities **adequate** for your instructional program?

Safety showers	Yes ☒	No ☐	Hoods	Yes ☒	No ☐
Eye washers	Yes ☒	No ☐	Ventilation	Yes ☒	No ☐
Fire extinguishers	Yes ☒	No ☐			

b. If no is checked for any item above, please explain.

4.7 a.

	Yes	No
Does the department/university have established safety rules?	☒	☐
Does the department/university have emergency reporting procedures?	☒	☐
Does your department have a written chemical hygiene plan?	☒	☐
Are there adequate facilities and arrangements for disposal of chemical waste?	☒	☐
Are safety information and reference materials (e.g., MSDS, SDS, SOPs) readily available to all students and faculty?	☒	☐
Is appropriate personal protective equipment available and used by all students and faculty?	☒	☐

b. If no is checked for any of the above, please explain.

c. Does the chemistry department or program have a safety committee or safety officer? Yes ☒ No ☐

If a safety committee exists, how often does it meet?

2 times per semester, or more frequently as needed

Section 5: Curriculum

5.1 a. Are all foundation courses taught annually? Yes ☒ No ☐

b. If no is checked above, indicate the foundation courses that are **not** taught annually.

c. If all of the courses required for student certification are not taught annually, describe how students can complete the requirements for a certified chemistry degree within four years.

Some of the advanced courses are taught on a regular alternate year schedule that is available in advance to both students and faculty advisers. The scheduled meeting times are cooredinated with other departments to prevent/minimize scheduling conflicts.

d. Are at least four semester-long (or six quarter-long) in-depth courses taught annually, exclusive of research? Yes ☒ No ☐

5.2 Refer to section 5.6 of the ACS Guidelines for the definition of degree tracks and **list only those degree tracks that lead to an ACS-certified bachelor's degree** in chemistry or related field.

Track 1 BS Chemistry (ACS)
Track 2 BS Biochemistry (ACS)
Track 3 BS Forensic Chemisty (ACS)
Track 4
Track 5
Track 6
Track 7

5. 3 Please report the number of hours in each course listed below in Table 5.1 that reflects supervised, hands-on lab experience.
CHEM 115 has a total of 28 supervised laboratory hours

Complete Tables 5.1 – 5.4 only for those courses in degree tracks that may lead to an ACS-certified bachelor's degree.

Table 5.1 – Introductory Course Work

List all introductory chemistry course work students may use to prepare for the foundation course work listed in Table 5.2. Do not include courses listed in Table 5.2 and 5.3 or courses that are not used for ACS certification purposes. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Credit Hours	Tracks[2]						
		Class	Lab			1	2	3	4	5	6	7
CHEM 115	General Chemistry	58	28	Chemistry and Chemical Reactivity, Hybrid Edition by Kotz	5	R	R	R	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–

1. Total Hours refers to the total contact hours per term. Do not record credit hours or contact hours per week in this column.
2. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose for each degree track.

Table 5.2 – Foundation Course Work

List below all course work students may use to satisfy the FOUNDATION requirements in the sequence suggested for ACS certification. Do not include courses listed in Tables 5.1 and 5.3 or courses that are not used for ACS certification purposes. Refer to Section 5.3 of the ACS Guidelines for the definition of a foundation course. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	CH[2]	Subdisciplinary % Breakdown[3]					Tracks[4]						
		Class	Lab			A	B	I	O	P	1	2	3	4	5	6	7
CHEM 116	General Chemistry II-Intro to Physical Chemistry	58	42	Chemistry and Chemical Reactivity, Hybrid Edition by Kotz	5			10		90	R	R	R	–	–	–	–
CHEM 225	Organic Chemistry I	44	42	Organic Chemistry, David Klein, 1st Edition	4				100		R	R	R	–	–	–	–
CHEM 231	Quantitative Analysis	44	42	Quantitative Chemical Analysis by D. C. Harris	4	100					R	R	R	–	–	–	–
CHEM 261	Inorganic Chemistry	44	42	Descriptive Inorganic Chemistry. Rayner-Canham and Overton	4			100			R	R	R	–	–	–	–
CHEM 351	Introductory Biochemistry	44	42	Lippincott's Illustrated Review: Biochemistry (Harvey and Ferrier) 5th	4		100				R	R	R	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. State the approximate percentage of each subdiscipline found in each course (analytical chemistry (A), biochemistry (B), inorganic chemistry (I), organic chemistry (O), and physical chemistry (P)). The percentage coverage must add up to 100% for each course. For example, Biophysics I might be 40% biochemistry and 60% physical or Organic Chemistry I might be 100% organic.
4. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose to meet the foundation requirements for each degree track.

Table 5.2 – Foundation Course Work (continued)

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	CH[2]	Subdisciplinary % Breakdown[3]					Tracks[4]						
		Class	Lab			A	B	I	O	P	1	2	3	4	5	6	7
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
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											–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. State the approximate percentage of each subdiscipline found in each course (analytical chemistry (A), biochemistry (B), inorganic chemistry (I), organic chemistry (O), and physical chemistry (P)). The percentage coverage must add up to 100% for each course. For example, Biophysics I might be 40% biochemistry and 60% physical or Organic Chemistry I might be 100% organic.
4. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose to meet the foundation requirements for each degree track.

5.4 If any courses are listed as alternative courses in Table 5.2, please explain how students satisfy the foundation requirements for certification for each degree track. List the names and course numbers. If a course is listed here, ensure it is also entered in Table 5.2.

Table 5.3 – In-Depth Course Work

List the in-depth course work used for ACS certification. Do not include courses listed previously in Tables 5.1 and 5.2. Refer to Section 5.4 of the ACS Guidelines for the definition of an in-depth course. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Foundation Prerequisite Course #	CH[2]	Tracks[3]						
		Class	Lab				1	2	3	4	5	6	7
CHEM 226	Organic Chemisty II	44	42	Organic Chemistry, David Klein, 1st Edition	CHEM225	4	R	R	R	–	–	–	–
CHEM 310	Applied Spectroscopy	44	42	Spectrometric Identification of Organic Compounds" (7th ed), R.M. Silverstein, et. al. 2005.	CHEM226 CHEM261	4	E	E	E	–	–	–	–
CHEM 332	Instrumental Analysis	44	42	Undergraduate Instrumental Analysis by J.W. Robinson, E. M. Skelly-Frame, G.M. Frame II, 6th	CHEM 231	4	R	R	R	–	–	–	–
CHEM 341	Environmental Chemistry	44	42	Environmental Chemistry 8th ed S. Manahan	CHEM 231 CHEM 225	4	E	E	E	–	–	–	–
CHEM 353	Introductory Toxicology	44		Casarett & Doull's Toxicology: The Basic Science of Poisons by Klaassen	CHEM 225 CHEM 351	3	E	R	R	–	–	–	–
CHEM 361	Physical Chemistry I	58		Physical Chemistry.Silbey, Alberty, Bawendi, Wiley,4/E 2005	CHEM 116	4	R	E	E	–	–	–	–
CHEM 362	Physical Chemistry II	44		Physical Chemistry. Silbey, Alberty, Bawendy, Wiley,4/E	CHEM 116	3	R	E	E	–	–	–	–
CHEM 363	Physical Chemistry Lab		42	None	CHEM 116	1	R	R	E	–	–	–	–
CHEM 445	Forensic Science	44	42	Forensic Chemistry Handbook by Kobilinsky	CHEM 231 CHEM 332	4	E	E	R	–	–	–	–
CHEM 452	Adv Bochemical and Molecular Tec	28	56	Lippincott's Illustrated Review: Biochemistry (Harvey and Ferrier) 5th Ed	CHEM 351	4	E	R	E	–	–	–	–
CHEM 461	Adv Inorganic Chem	44		Inorganic Chemistry. Miessler, Tarr. 5th Ed, Pearson Education, 2014	CHEM 231 CHEM 225 CHEM 261	3	E	E	E	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

Table 5.3 – In-Depth Course Work (continued)

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Foundation Prerequisite Course #	CH[2]	Tracks[4]						
		Class	Lab				1	2	3	4	5	6	7
CHEM 462	Adv Inorganic Chem Lab		42	None	CHEM 261	1	E	E	E	–	–	–	–
CHEM 495	Senior Project (undergraduate research)		84	None	N/A	2	R	R	R	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
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							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

Table 5.4 – Physics and Mathematics Courses

List the physics and mathematics course work required for ACS certification. Refer to Section 5.7 of the ACS Guidelines. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Department	Credit Hours	Tracks[2]						
		Class	Lab			1	2	3	4	5	6	7
MATH 112	Calculus for Business and Life Sciences	58		Math	4	E	_	R	_	_	_	_
MATH 151	Calculus I	58		Math	4	E	R	_	_	_	_	_
Math 152	Calculus II	58		Math	4	E	R	_	_	_	_	_
Math 305	Linear Algebra	44		Math	2	E	_	R	_	_	_	_
ENGR 245	Calculus Applications for Technology	28	28	Engineering	3	E	_	R	_	_	_	_
PHYS 221	Principles of Physics I	44	28	Physical Sciences	4	E	_	E	_	_	_	_
Phys 222	Principles of Physics II	44	28	Physical Sciences	4	E	_	E	_	_	_	_
PHYS 231	Applied Physics for Engineers and Scientists I	44	28	Physical Sciences	4	E	R	E	_	_	_	_
PHYS 232	Applied Physics for Engineers and Scientists II	44	28	Physical Sciences	4	E	R	E	_	_	_	_
						_	_	_	_	_	_	_
						_	_	_	_	_	_	_

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

5.5 How do your ACS-certified graduates **in each degree track** meet the in-depth course requirements? List the names, course numbers, and indicate if required or elective. If a course is listed here, ensure it is also entered in Table 5.3. Where a student may choose among two or more courses, clarify the options, and how many courses are required for certification.

BS Chemistry - Required: CHEM 226 Organic Chemistry II (Organic), CHEM 332 Instrumental Analysis (Analytical), CHEM 361 Physical Chemistry I (Physical), CHEM 362 Physical Chemistry II (Physical), CHEM Electives at the 300 level or higher (11 credits)

BS Biochemistry - Required: CHEM 226 Organic Chemsitry II (Organic), CHEM 332 Instrumental Analysis (Analytical), CHEM 452 Advanced Biochemical Mol Tech (Biochemistry), 4 cr CHEM electives (either CHEM 361 or 362 for certification, Physical)

BS Forensic Chemistry - Required: CHEM 226 Organic Chemistry II (Organic), CHEM 332 Instrumental Ananlysis (Analytical), 3 cr CHEM Electives (must be either CHEM 361 or 362 for certification, Physical)

5.6 How do ACS-certified graduates **in each degree track** meet the laboratory requirement of 400 hours? Include the subdisciplinary area (ABIOP) covered by each course, the course name, the course number, the number of lab hours devoted to each area, and indicate whether courses are required or elective. Please record the total number of labs hours for the courses listed in each track. Do not include lab hours from general or introductory lab courses. If a course is listed here, ensure it is also entered in Table 5.2 or 5.3.

Example: Organic Chemistry II (CH 232), Organic 45 hours

BS Chemistry, Required - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Physical Chemistry Lab (CHEM363), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231); Analytical 42 hrs, Instrumental Analysis (CHEM 332), Analytical 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs; Inorganic Chemistry (CHEM 261); 42 hrs; Senior Project (CHEM 495), 84 hrs. Chemistry Electives also provide additional laboratory hours (minimum 420 hrs.)

BS Biochemistry, Required - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Physical Chemistry Lab (CHEM363), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231); Analytical 42 hrs, Instrumental Analysis (CHEM 332),Analytical 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs; Adv Biochem (CHEM 452), 56 hrs; Inorganic Chemistry (CHEM 261); 42 hrs; Senior Project (CHEM 495) 84 hrs (minumum 476 hrs.)

BS Forensic Chemistry - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231), Analytical 42 hrs; Instrumental Analysis (CHEM 332) Analytical, 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs, Inorganic Chemistry (CHEM 261), 42 hrs; Adv Biochemistry (CHEM 452), Biochemistry 56 hrs OR Applied Spectroscopy Analytical, 42 hrs; Senior Project (CHEM 495) 84 hrs. (minimum 420 hrs)

5.7 Describe the computational chemistry facilities and software (e.g., Gaussian) that students use in their course work and research.

A workstation with Spartan '14, and 10 workstations with Spartan Student are available in the instructional computer lab (CRW 107). One additional student workstation with Spartan Student and Titan is available in the introductory chemistry lab (CRW334).

5.8 How do students gain hands-on experience using chemical instrumentation?

Students gain hands on experience with instrumentation throughout the curriculum in both coursework and research. For instance, students in Orgainic Chemistry I (CHEM 225) use NMR and FTIR throughout the semester to characterize their products. Students in Instrumental Analysis (CHEM 332)gain experience with a range of analytical techniques, including instrumentation in each of the five areas of Optical Molecular Spectroscopy, Optical Atomic Spectroscopy, Mass Spectrometry, Chromatography, and Electrochemistry. In dpeth courses with laboratories provide additional hands on opportunities to use instrumentation. For instance, NMR and FTIR are also heavily used in Organic Chemisty II (CHEM 226), and Applied Spectroscopy (CHEM 310). Applied in depth courses such as Environmental Chemistry (CHEM 341) and Forensic Science (CHEM 445)have a strong analytical focus, and make use of a wide range of instrumental methods in the laboratory.

5.9 a. Are any classes required for student certification taught wholly online? Yes ☐ No ☒

b. If you are having problems or concerns with the arrangements for these courses, please describe them.

Section 6: Undergraduate Research

6.1 Undergraduate Research

a. Do you use undergraduate research to fulfill certification requirements for lab hours?
Yes ☒ No ☐

b. Do you use undergraduate research to fulfill certification requirements for in-depth course work?
Yes ☒ No ☐

If yes to either question above, is a comprehensive written report required? Yes ☒ No ☐
If no, go to Item 6.3

6.2 Submit a sample of the comprehensive student research reports or theses representative of multiple disciplines and faculty, with the grade the student received indicated on each report. Also indicate on each report the number of terms (semesters or quarters) and actual student hours per term of research covered by the report.

Number submitted 4 (3-5 reports, 5 maximum)

6.3 Report on the participation in undergraduate research during the last five years.

a. Number of undergraduate majors (all degrees offered by your program) who participated in a research experience 45

b. Number of chemistry faculty who were regularly involved in research with undergraduates 7

6.4 If undergraduate research done outside of your institution is used to satisfy certification requirements, are students required to submit a comprehensive written research report that a faculty member at your institution evaluates and approves?

Yes ☒ No ☐ Not applicable ☐

6.5 How are students provided with experiment-specific safety education and training?

In coursework, student receive safety instruction from the instructor prior to beginning each experiment. Students also prepare research proposals in Junior Seminar (CHEM 395) which include sections on experimental methods and laboratory safety. These proposals are reviewed by the department chair and faculty supervisor prior to approval. Students must complete an appropriate safety training program with the laboratory manager, then receive additional safety instruction from the faculty supervisor.

Section 7: Student Skills

7.1 Describe the experiences that develop student professional skills in problem-solving, oral/written/presented communication, teamwork, and ethics (responsible scientific conduct).

While each of these skills is developed in multiple courses throughout the curriculum, problem solving, communication, and ethics are most thoroughly focused on in the CHEM 395, CHEM 495, and CHEM 499 research sequence. In CHEM 395, a research proposal is developed, presented, and revised based on feedback from faculty and other students. Experimental design, and research ethics are also addressed in this course. IN CHEM 495, research is conducted under the close supervision of a faculty mentor. In CHEM 499, The results of the research are presented publicly through a poster symposium, an oral presentation, and a written paper. Teamwork and team problem solving are developed throughout the curriculum through group exercises both in classes and in laboratories.

7.2 Describe how your students gain experience with the effective retrieval and use of chemical literature, data management, archiving, and record-keeping.

Retrieval and use of the chemical literature is taught early in the curriculum beginning with CHEM 225 (typicall fall semester sophomore year). Record keeping is similarly taught thoughout the curriculum through the instruction on and use of proper laboratory notebooks. While laboratory notebooks for coursework are typically not archived, laboratory notebooks, electronic data, and final products for research projects are archived indefinitely (electronic files are backed up on an external server). Additional specific instruction on data management etc. is provided during the undergraduate research sequence.

7.3 Describe how your program conveys safe lab practices and safety risk assessment to students throughout their undergraduate experience. When and where is the first safety instruction delivered?

Safety is taught throughout the curriculum beginning with CHEM 115. At the beginning of each course, a standardized laboratory safety handout is distributed to the students, and safe practices are described by the instructor. Students then sign a form acknowledging they have received general laboroatory safety instruction and the signatures are archived. Instructors also provide additional safety instruction at the beginning of each lab on potential hazards of that days experiment. Students conducting research and student employees must watch a series of videos annually, and pass a safety quiz in addition to receiving specific safety training from the faculty mentor or supervisor.

7.4 How are all of the student skills describe in Items 7.1, 7.2, and 7.3 assessed?

These skills are assessed both qualitatively and quantitatively through a variety of techniques, but the most effective assessment technique involvesobservation and quantitative assessment of students engaging in undergraduate research. Use of the chemical literature is assessed in CHEM 395 Jumior Seminar. During CHEM 495 Senior Project, individual faculty members assess student progress as the research is being executed (including safety, with feedback from routine safety inspections). In CHEM 499 (Senior Thesis) the faculty as a whole provide feedback on the oral and poster presentations, whicle the written paper is evaluated by the faculty mentor and the course instructor.

Section 8: Program Self-Evaluation

8.1 Describe the program self-evaluation activities that your department has undertaken over the past five years. Provide quantitative information, if available.

Lake Superior State University requires comprehensive program review to occur on a regular 5 year rotating schedule. The BS Chemistry & Biochemistry (including secondary ed) degrees were reviewed during the 2013-2014 academic year, while the Forensic Chemistry was reviewed during the 2014-2015 avademic year. The program review documents enrollment trends, staffing levels, graduate placement, student satisfaction, the adequacy of facilities, the acheivement of program learning outcomes, and course level assessment. At LSSU, assessment data for course level and program level learning outcomes is archived in TracDat software. Many courses use ACS exams to evaluate student learning. For example, The past four semesters of general chemistry had class averages of 38.5, 35.7, 37.8, and 40.7 on the 1997 First Semester Exam (average 39.4). Discussions of curriculum items Each fall, the Chemistry Faculty meets to prioritize facilities and instrumentation aquisition and potential funding sources (including submissions to NSF-MRI). LSSU has a fund available to the sciences at the Deans level for replacement of equipment and Instrumentation, and these funds have been used to acquire several instruments designated as priorities by the faculty including a new electrochemical workstation, MP-AES, and Ion Chromatograph in the last two years. Currently, the department is investigating the possibility (and practicality) of acquiring cryogenic NMR to better support research and instruction in Organic Chemistry.

8.2 **Describe how the results of your department's self-evaluations have been used to improve student learning, student skills, exploration of alternate pedagogies, and the effectiveness of the chemistry program.**

Several changes have resulted from the self evaluation process. We have acquired several instruments over the past five years to better support student learning, undergraduate research, and faculty scholarship. We also recently expanded our computational chemistry facilities. We are currently working on curriculum changes to improve the physical chemistry sequesnce, increase student use of computational chemistry software, increase coverage of polymer chemistry, and exapnd the series of seminar courses such that students would take a seminar course in each year of study. The changes to the seminar sequence we expect to particularly improve development of student skills in use of the chemical literature, scientific writing, and career development. We are also working with the English department to explore the possibility of offering specialized course sections of second semester english compsition for STEM majors, with the goal of formally intruducing scientific writing in the freshman year. Other changes include the improvement of safety instruction, including the requirement that students working on undergraduate research projects undergo a more rigorous safety training process than in the past.

Final Comments

Please comment on (in as much detail as you wish) changes in the last five years in faculty, diversity initiatives, professional development, support personnel, facilities, capital equipment, curriculum, and any other items related to your program that you believe would be of interest to CPT. We are especially interested in any new programs you are about to undertake. Use additional sheets, if necessary. Please do not include actual self-evaluation documents or reports.

Over the past five years, we have added an additional full time staff memeber for lab prep and instrument maintenance and repair. We requested campus wide access to SciFinder, and received support from the administration to implement it in 2012. We requested, and were granted, an additional budget for instrument maintenance and replacement through the Deans Fund which totals ~$120,000 annually for the sciences. We added new instrumentation in electrochemistry (electrochemical workstation consiststing of a potentiostat, cell stand, various electrodes, and software) in 2014, which has been incorporated into the instrumental analysis course and undergraduate research. We are also currently investigating the addition of a cryogenic NMR. Additionally, we are pursuing severalcurriculum improvements as described in section 8.2. With regard to facilities, we were granted additional laboratory space in 2011, to support our SEM and to support additional faculty research. In 2014, the university increased annual professional development funds from $800 to $1000, and has also begun redistributing a portion of grant indirect cost revenues to the PI's and the Departments as additional professional development funds.

LAKE SUPERIOR STATE UNIVERSITY

57	19	68	16
La	K	Er	S
138.91	39.10	167.26	32.07

B.S. Biochemistry Pre-Professional (Effective 2016)

Name_____ **ID#** _____ **Advisor**_____

Expected Date of Graduation_____ **Chair Approval** _____

Chemistry Degree Requirements (48 cr min)		Sem./Grade
CHEM115 General Chemistry I	5	____/____
CHEM116 General Chemistry II	5	____/____
CHEM225 Organic Chemistry I	4	____/____
CHEM231 Quantitative Analysis	4	____/____
CHEM261 Inorganic Chemistry	4	____/____
CHEM326 Organic Chemistry II	4	____/____
CHEM332 Instrumental Analysis	4	____/____
CHEM351 Introductory Biochemistry	4	____/____
CHEM353 Introductory Toxicology	3	____/____
CHEM 361 Physical Chemistry I	4	____/____
CHEM363 Physical Chemistry Lab	1	____/____
CHEM395 Junior Seminar	1	____/____
CHEM452 Adv. Biochem./Mol. Tech.	4	____/____
CHEM499 Senior Seminar	1	____/____

Degree Audit Sheet Directions: Fill in the semester and grade for each course as completed. Two semesters before your intended graduation date this form should be filled in indicating the courses you are then taking, and those you will take in the next semester. Have the form signed and submit to the Fletcher Center with your Declaration of Candidacy form. You must have a signed Course Substitution/Waiver Form for any deviations from the audit below – see your advisor for this form.

For American Chemical Society certified degree, additionally required:

CHEM495 Senior Project	2	____/____

ACS Chemistry for Life™

AMERICAN CHEMICAL SOCIETY

See Department Chair for special rules regarding ACS certification

Biology Courses (16 credits)		
BIOL131 General Biology: Cells	4	____/____
BIOL132 General Biology: Organisms	4	____/____
BIOL220 Genetics	4	____/____
Any BIOL 400 level course	4	____/____

Support Courses (19 credits)		
•BUSN211 Business Statistics	3	
or		
•MATH207 Princ of Statistical Meth	3	____/____
•MATH151 Calculus I	4	____/____
•MATH152 Calculus II	4	____/____
•PHYS231 Applied Physics I	4	____/____
•PHYS232 Applied Physics II	4	____/____

General Education (25 credits minimum)

ENGL 110 First-Year Comp	3	____/____	ENGL111 First-Year Comp II	3	____/____
Approved Social Science*	3	____/____	Approved Social Science*	3	____/____
HUMN251 Humanities I	4	____/____	Approved Humanities*	3	____/____
COMM101 Speech	3	____/____	Approved Social Diversity*	3	____/____

*Consult list for approved courses

General Electives credits must be completed for a minimum of 124 total credits (16 credits)

_____ _____ _____ _____ _____

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_____
Dean Date

___ At MINIMUM of 124 total credits

___ 2.5 GPA Overall ___ 2.5 GPA in major

Effective Date: Fall 2016

Typical B.S. Biochemistry Pre-Professional Sequence ACS Certified Degree (124 Credits Minimum)

Fall Freshman CHEM115 General Chemistry I (5) MATH151 Calculus I (4) BIOL131 General Biology: Cells (4) *ENGL110 First-Year Composition I (3) Total: 16 ***(If Pre-Pharm: Consider BIOL121) (Fall)**	Spring Freshman CHEM116 General Chemistry II (5) MATH152 Calculus II (4) BUSN211 Business Statistics (3) (or MATH207 Principles Of Statistics (3)) *ENGL111 First-Year Composition II (3) Total: 15 ***(If Pre-Pharm: Consider BIOL122) (Spring)**
Fall Sophomore CHEM225 Organic Chemistry I (4) CHEM231 Quantitative Analysis (4) (Fall) BIOL220 Genetics (4) (Fall) PHYS231 Applied Physics I (4) (Fall) Total: 16	Spring Sophomore CHEM326 Organic Chemistry II (4) (Spring) CHEM261 Inorganic Chemistry (4) (Spring) BIOL132 General Biology: Organisms (4) PHYS232 Applied Physics II (4) (Spring) Total: 16
Fall Junior CHEM351 Biochemistry I (4) (Fall) SOCY103 Cultural Diversity (3) HUMN251 Humanities I (4) *General Elective (4) Total: 15 ***(If Pre-Pharm: Consider BIOL204)**	Spring Junior CHEM332 Instrumental Analysis (4) (Spring) CHEM395 Junior Seminar (1) (Spring) CHEM353 Toxicology (3) (Spring) Approved Social Science ** (3) General Elective (4) Total: 15
Fall Senior CHEM361 Physical Chemistry I (4) CHEM363 Physical Chemistry Lab (1) CHEM495 Senior Project (2) COMM101 Fund of Speech Communication (3) General Elective (4) Approved Social Science ** (3) Total: 17	Spring Senior CHEM499 Senior Seminar (1) CHEM452 Adv. Biochemical/Mol. Tech. (4) (Spring) BIOL4XX level course (4) General Elective (3) Approved Humanities** (3) Total: 15

** Consult official University list of approved General Education Courses
(Fall) = Course typically only offered Fall semester, some might be alternate years.
(Spring) = Course typically only offered Spring semester, some might be alternate years.

CHEM 499 Abstracts for Biochemistry Majors
Spring 2018

Student: Steven B. Davies
Major: Biochemistry
Title: Synthesis and Microbial Evaluation of 3,4-Dihydroquinazolines Varying at the N-3 and C-4 Positions
Abstract: Antibiotic resistance has become a major threat to public health as the number of resistant infections is steadily increasing. The development of new antimicrobial compounds has become an integral part in combatting this mounting resistance. Many nitrogen-containing heterocycles including quinolones, quinazolines, and quinazolinones have demonstrated activity against resistant bacterial strains such as methicillin-resistant *Staphylococcus aureus* (MRSA). The 3,4-dihydroquinazoline is an underexplored class of compounds that is structurally similar to the ones described above. Current methods on their synthesis are difficult, expensive and do not offer structural diversity. This has led to development of a new multicomponent approach for the synthesis of 3,4-dihydroquinazolines allowing for the formation of diverse members of this compound class using commercially available amides, amines, and aldehydes. By reacting these starting materials with trifluoromethanesulfonic anhydride in the presence of a base, dihydroquinazoline products are formed. The specific focus of this project was to vary the aldehydes and amines used in the reaction, rendering dihydroquinazolines with different substituents at the N-3 and C-4 positions. In doing so, we were able to investigate changes in the yields and antimicrobial activity.

Student: Elliot Furr
Major: Biochemistry
Title: PCR and Its Use in Fresh Water Bacterial Analysis
Abstract: Polymerase chain reaction (PCR) is a technique widely used throughout many biological and biochemical fields. Its widespread use has allowed the method to grow over the last 35 years into many unique techniques that fit almost any biological research. This paper reviews the history of PCR and analyzes a method for quantifying freshwater bacterial (*E. coli*) contamination using qPCR (or real time PCR\ quantitative PCR). While PCR is useful, it is difficult to implement this method for accurately quantifying bacterial contamination due to some issues. Using information gathered from various journals and SOPs outlining this technique, this paper explains how this method is used and describes the difficulties this method faces. The use of PCR in this application is currently limited, but in the near future it can become the standard for all fecal bacterial contamination detection.

Student: Travis Quevillon
Major: Biochemistry
Title: A Suzuki Reaction Approach to the Regioselective Synthesis of 5,7-Disubstituted 3,4-Dihydroquinazolines
Abstract: The global health issue of antibiotic resistance has become more prevalent over recent years, alerting the CDC as they stress the desperate need for new antibiotic drugs to be developed. As fluoroquinolone compounds currently comprise one of the classes of antibiotics currently on the market, investigation of structurally similar heterocycle scaffolds has been prompted. Consequently, a multicomponent synthesis approach for 3,4-dihydroquinazolines has been used to synthesize and study the structure of these compounds in terms of their antimicrobial activity. In an attempt to expand the scope of the chemistry being performed in 3,4-dihydroquinazoline syntheses, various structural modifications have been introduced in a new synthesis method. More specifically, an aryl group has been incorporated at the beginning of the reaction sequence through installation via a

Suzuki reaction into a readily available bromonitroarene, or at a later stage via the same reaction of a halogenated 3,4-dihydroquinazoline. These two methods allow for the installation of two different R groups which are meta to each other and the nitrogen on the aryl group of the compound being explored. Both of these routes have been explored in this project, and the positive and negative outcomes of each route have been compared in terms of the reaction yields and regioselectivities.

Student: Ryan Renz
Major: Biochemistry
Title: Short Peptide Inhibition of Snake Venom Metalloproteinases
Abstract: The gene oprin found in the *Didelphis virginiana,* exhibits inhibition of rattle snake venom, namely a class of proteins called metalloproteinases. Since the discovery of this immunity in the 1970's, isolation, purification, and sequencing of the gene has occurred, and was termed oprin. Short peptides derived from the oprin protein have been examined, and shown to exhibit similar inhibitory qualities, though little work has been done to create a viable antivenin from these peptides. A solid phase peptide synthesis (SPPS) method was used to generate short peptides that mimic those found on the oprin protein. The sequence N-LKAMDTTPRL-C, which is the known amino acid sequence found on the N-terminus of oprin, was assembled and purified using HPLC analysis. Fractions of interest, obtained from the preparative HPLC data, were then tested using an azocoll collagenolytic assay to probe the inhibitory qualities of the peptide synthesized. Positive structural characterization of the synthesized peptide was not in the current scope of the project. Biological evaluation of the inhibitory properties was instead preformed.

Student: Tyler Wall
Major: Biochemistry
Title: Synthesis and Antimicrobial Evaluation of 3,4-Dihydroquinazolines Varying About the C-2 Position
Abstract: The interest in novel therapeutic chemical compounds to contest an increasing prevalence of antibiotic resistance has continued to grow. The quinolone class of antibiotics has been in clinical use since 1962 and has been made popular due to their broad-spectrum antibiotic properties. Recently, studies have demonstrated that the related quinazoline and quinazolinone heterocycles also feature antimicrobial activity. Some of these heterocycles have even displayed activity against resistant bacterial strains such as methicillin-resistant *Staphylococcus aureus* (MRSA). We sought to determine whether the structurally related 3,4-dihydroquinazolines, an underexplored class of heterocycles, might have similar antimicrobial properties. We have recently developed a multicomponent synthesis of 3,4-dihydroquinazolines to overcome issues plaguing prior syntheses of the heterocyclic scaffold. The aim of this study was to expand the scope of our reaction and to screen newly synthesized 3,4-dihydroquinazolines for antimicrobial activity against MRSA with focus on the C-2 position of the heterocyclic scaffold.

Student: Nicole Zizelman
Major: Biochemistry
Title: Expression, Purification, and Crystallization of Phytase from *Xanthomonas oryzae pv. Oryzae*
Abstract: Phytase is a phosphatase enzyme that hydrolyzes phytic acid, a substance commonly found in grains, and causes release of phosphorus into the environment. When phytic acid is bound to minerals in soil and manure, it exists as phytate and releases phosphates. Phytic acid is found in various plants, animals, and microorganisms. It is also present in some feed ingredients that non-ruminant animals cannot break down. Since fecal waste of non-ruminant animals is used as fertilizer,

the phytic acid that they are unable to break down pollutes the surrounding environment by increasing the phosphorus level. The overabundance of this phosphorus in water and nutrients cause eutrophication, which results in a loss of oxygen content in bodies of water and increase growth of algae. There are several methods that can reduce the amount of phosphorus in the environment, one of which is the use of biofertilizer. This review will study the methods to crystallize purified protein from PXO_04860 phytase gene from *Xanthomonas oryzae pv. oryzae*.

Article

^{31}P NMR of the Pyruvate Kinase Reaction: An Undergraduate Experiment in Enzyme Kinetics

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Abstract

Understanding how to perform an enzyme assay is a critical learning skill in the undergraduate biochemistry curriculum. Students in biochemistry typically have been exposed to the use of NMR spectroscopy as a tool to determine chemical structure, but rarely are they exposed to the utility of NMR to evaluate enzyme kinetics. Furthermore, coverage of NMR experiments utilizing "alternative nuclei", such as ^{15}N, ^{19}F, and ^{31}P may be neglected. Herein we report a simple ^{31}P NMR tube experiment that allows students to examine the enzyme kinetics and equilibrium constant of the reaction catalyzed by pyruvate kinase. © 2017 by The International Union of Biochemistry and Molecular Biology, 45(6):509–514, 2017.

Keywords: *Upper level undergraduate; NMR spectroscopy; ^{31}P NMR; enzyme kinetics; enzyme assay; glycolysis; pyruvate kinase*

Introduction

An investigation of enzyme assay methods is a staple of undergraduate biochemical laboratory courses. These methods often involve monitoring the appearance or disappearance of either substrate or product using a spectrophotometric method such as UV/Vis spectroscopy. One common method is to monitor the production or disappearance of NADH at 340 nm in either a direct assay (i.e., lactate dehydrogenase, LDH) or an indirect enzyme-coupled assay (i.e., pyruvate kinase coupled to lactate dehydrogenase) [1]. A less common method to assay enzymatic activity in the undergraduate biochemistry laboratory is the use of nuclear magnetic resonance (NMR) [2–4].

As part of our laboratory course in biochemistry, we introduced an "enzyme assay" project that allows students to: (1) develop proposals for innovative assays of an enzyme found in glycolysis, (2) present these proposals to their classmates, and (3) collaboratively decide which proposal to implement in the class. Students were given a limited budget for the project, so they had to carefully consider the cost of commercially available reagents as part of their proposal. Over the years, there have been many interesting approaches to this assignment, from the use of luciferase to assay hexokinase to cell apoptosis to assay pyruvate kinase, but one stands out that we feel should be highlighted. This approach drew on discussions from the lecture on the use of NMR to study biomolecules utilizing "alternative nuclei" (i.e., ^{15}N, ^{19}F, and ^{31}P). The proposal that students supported was the development of a direct enzymatic assay for pyruvate kinase (PK) by monitoring the appearance (or disappearance) of ^{31}P NMR signals over time in a single NMR tube reaction.

For this study, the students chose to examine commercially available PK from rabbit muscle, an enzyme that exists as a tetramer of equal subunits with molecular weight of 57 KDa [5]. PK catalyzes the conversion of adenosine diphosphate (ADP) and phosphoenol pyruvate (PEP) to adenosine triphosphate (ATP) and pyruvate (Fig. 1) with a Gibbs free energy change of −31.4 KJ/mol, an associated equilibrium constant (K_{eq}) of 3.2×10^5 with reported K_M values of 0.3 mM for ADP, and 0.07 mM for PEP (Note: the reported K_M values for ATP and pyruvate are 0.86 and 10 mM, respectively) [1, 6–8]. Both Mg^{2+} and K^+ ions are required co-factors for optimal activity and the enzyme is inhibited by Ca^{2+} ions [5, 9]. PK can utilize other dinucleotide phosphates as substrates including GDP, IDP, dADP, UDP, CDP, dCDP [5], and the pH optimum for PK is 7.5 in 50 mM phosphate buffer. The mechanism utilized by PK has been described in the literature including ^{13}C NMR studies suggesting the direct transfer of the PEP-phosphate to the β-phosphate of ADP, thus forming ATP [1, 10, 11]. Standard enzymatic assays of PK include monitoring the

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Phosphorylation reaction catalyzed by pyruvate kinase (PK).

FIG 1

disappearance of PEP by UV spectroscopy [12], or the lactate dehydrogenase coupled assay monitoring the appearance of NADH [1, 13, 14].

Several additional factors were presented that convinced the class to support this project. First, the enzyme and all necessary reagents were commercially available at a reasonable cost (see Supporting Information). Second, the equilibrium constant (K_{eq} = 3.2 × 10^5) for this reaction is sufficiently large to expect almost complete conversion of starting material to product [8]. Third, due to favorable solubility in water, the reactant concentrations could be high allowing for rapid NMR signal acquisition. Finally, and most importantly, a review of the literature revealed that the ^{31}P NMR signals of both the starting materials (PEP and ADP) and product (ATP) are sufficiently resolved to allow for direct integration of spectral peaks and calculation of reactant to product ratios [1, 15–20]. This study builds upon earlier work on the enzyme kinetics of PK utilizing ^{31}P NMR and seeks to present a simplified approach for the undergraduate biochemistry laboratory [16].

Experimental Procedures

Materials

The following were purchased from Sigma-Aldrich: rabbit muscle pyruvate kinase (PK, E.C. #: 2.7.1.40) ammonium sulfate suspension (stated activity: 500 U/mL), phospho(enol)pyruvic acid monopotassium salt (PEP, MW = 206.13 g/mol) (Note: the potassium salt of PEP was found to have fewer impurities than the commercially available sodium salt by ^{31}P NMR analysis), and adenosine diphosphate sodium salt (ADP, MW = 427.20 g/mol). Aqueous stock solutions of 1 M $MgCl_2$ and 1 M KCl were prepared with the reaction buffer consisting of 1 M imidazole at pH 7.5 in HPLC grade water. The use of imidazole buffer was necessary because phosphate containing buffers (i.e., PBS) would interfere with integration of the PEP ^{31}P NMR signal near 0.0 ppm.

NMR Tube Reaction Conditions

Reactions were prepared by weighing 22.2 mg ADP (52 μmol) and 10.1 mg PEP (49 μmol) into a 1.5 gram glass vial (PEP was limiting). Imidazole buffer (0.76 mL) was added along with 5 μL of 1 M $MgCl_2$ and 15 μL of 1 M KCl. (Note: no D_2O was required for this experiment because the NMR that was used does not utilize a deuterium lock signal). This reaction mixture (representing t = 0 min) was added to a standard 5 mm NMR tube via glass pipette, and a ^{31}P NMR spectra was obtained (see NMR conditions below). The enzymatic reaction was initiated upon addition of 20 μL (~10 U) of pyruvate kinase to the NMR tube (stock enzyme solution was ~500 U/mL, diluted to 0.5 U/mL in imidazole buffer) giving a final reaction volume of 0.8 mL. (note: we chose to use 10 U of enzyme for a more dramatic demonstration of ADP → ATP conversion, see "Discussion" below) The final reaction concentrations were: 65 mM ADP, 61 mM PEP (limiting), 6 mM $MgCl_2$,19 mM KCl, and approximately 12.5 U PK/mL. Importantly, it was found that higher concentrations of $MgCl_2$ (50 mM) caused significant line broadening and signal degradation due to paramagnetic effects [16]. Upon addition of the enzyme, the NMR tube was quickly placed in the spectrometer and ^{31}P NMR spectra were collected at time intervals of 1, 11, 21, 31, 41, 51, and 1440 min. The initial reaction temperature was approximately 25°C and was not carefully controlled when the NMR tube was initially charged with reagents; however, the reaction temperature was kept constant at 30°C over the 24 h duration of the experiment by the NMR probe heater.

NMR Conditions

The ^{1}H broadband decoupled NMR spectra were collected on an EM-360 Varian instrument with the EFT-60 Anasazi FT NMR upgrade (note: this system does not have a deuterium lock signal). On this instrument, the observe frequency for ^{31}P is 24.31 MHz. Before acquisition of spectra for each time value, the field offset was externally set to the signal corresponding to PEP (note: the ^{31}P signal of unbound PEP is located at 0.9 ppm relative to 85% phosphoric acid [16], thus an internal reference was omitted so that integration of the PEP signal was possible). In order to compare data appropriately, this field offset was reset before each experiment to account for slight differences in magnetic drift. The relaxation delay was set to 5 s to allow for complete relaxation of bulk magnetization, thus allowing for accurate integration of ^{31}P NMR signals [17]. A total of 8 scans, requiring approximately 45 s for acquisition, were performed at the following time intervals (0, 10, 20, 30, 40, 50, 1439 min). Due to the 45 s delay, the actual time the experiments were completed represented approximately 1 min after the acquisition began (1, 11, 21, 31, 41, 51, 1440 min). FIDs were processed using NUTS NMR software (Anasazi) with a line broadening of 1.0 Hz. Integrals over the same spectral regions were obtained for the ^{31}P

signals from each NMR experiment, and a stack plot was generated (Fig. 2).

Hazards

The reagents and enzyme used in this experiment present no reported physical hazards. The preparation of 1 M imidazole buffer requires the use of 3 M NaOH. Students should wear appropriate safety protection. A discussion of magnetic fields should always be included when using an NMR, including the hazards related to pacemakers or other medical devices that could be affected by a strong magnetic field. These hazards are minimized when using a 60 MHz magnet as described.

Discussion

Calculation of Enzymatic Activity from NMR Integration of ^{31}P Signals

The ^{31}P signals that were used to calculate enzymatic activity were the phosphate of PEP (0.0 ppm—set as external standard) and the β-phosphate of ATP (–20.5 ppm). The ^{31}P

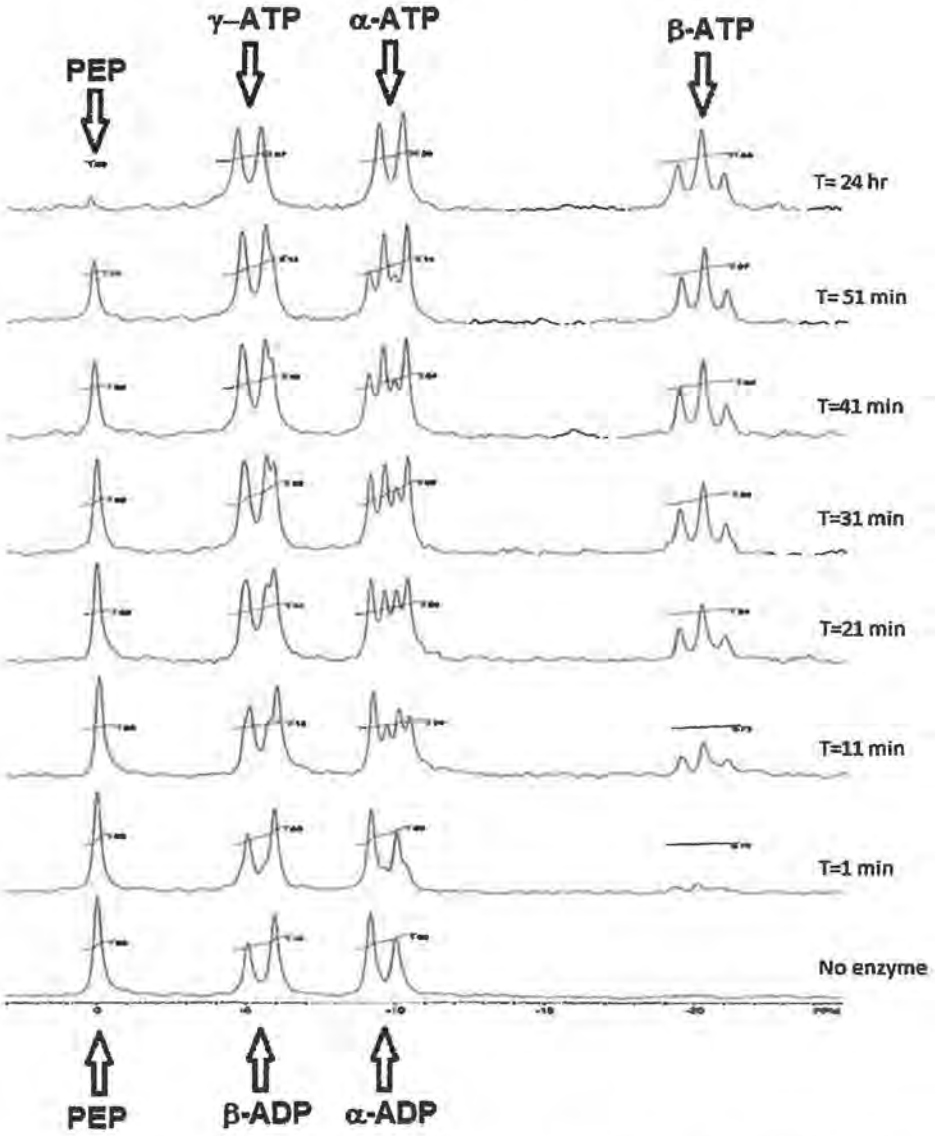

FIG 2 *A representative stack plot of ^{31}P NMR (^{1}H broadband decoupled) spectra results for a single NMR tube reaction monitoring the pyruvate kinase mediated conversion of PEP and ADP to pyruvate and ATP. The reaction was initiated by the addition of pyruvate kinase. The initial concentrations of PEP and ADP were 61 and 65 mM, respectively. The reaction buffer was 1 M imidazole at pH 7.5 and contained 6 mM $MgCl_2$ and 19 mM KCl. As the reaction progressed, integrations of the ^{31}P signals for the β-phosphate of ATP (–20.5 ppm) were compared to those of the phosphate in PEP (0 ppm).*

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TABLE I *Integration results of ^{31}P NMR experiment*

		^{31}P integrals						
Time (min)	*PEP*	*β-ADP + γ-ATP*	*α-ADP + α-ATP*	*β-ATP*	*Fract. PEP*	*μmol PEP*	*Fract. ATP*	*μmol ATP*
0	1	1.46	1.6	0	1.000	49.0	0.000	0.0
1	1	1.65	1.69	0.19	0.840	41.2	0.160	7.8
11	1	2.13	2.38	0.73	0.578	28.3	0.422	20.7
21	1	2.62	2.86	1.24	0.446	21.9	0.554	27.1
31	1	2.92	3.02	1.55	0.392	19.2	0.608	29.8
41	1	3.45	3.64	2.04	0.329	16.1	0.671	32.9
51	1	4.12	4.14	2.57	0.280	13.7	0.720	35.3
1440	1	33.87	36.26	31.5	0.031	1.5	0.969	47.5

Integrals were combined for the β-ADP and γ-ATP ^{31}P signals as well as for the α-ADP + α-ATP ^{31}P signals, due to spectral overlap. The fraction of PEP and ATP as well as the μmol PEP lost and ATP formed were calculated using Eqs. 1–4.

signals representing the α- and β-ADP phosphates for pure ADP (time = 0) are well resolved, however, as the reaction proceeds, a mixture of these signals along with the α- and γ-ATP phosphate signals overlap at approximately −5.5 and −10 ppm (Fig. 2).

Integration Results

The integral for the PEP ^{31}P signal was set to a relative value of 1.0 for each separate NMR experiment (Table I).

To calculate the relative fractions of PEP and ATP formed over time, both (1) and (2) were applied:

$$\text{Fraction PEP} = (\text{Integral of PEP})/[(\text{Integral of } b\text{–ATP}) + (\text{Integral of PEP})] \quad (1)$$

$$\text{Fraction ATP} = 1 - \text{Fraction PEP} \quad (2)$$

For example, the integrals for the experiment at 11 min, gave the following result for Eq. (1): (1)/[(0.73) + (1)] = 0.578, meaning that after 11 min of reaction, 57.8% of the original PEP ^{31}P signal remained in the reaction. Applying Eq. (2): 1 - 0.578 = 0.422, meaning that 42.2% of the new ^{31}P signal at −20.5 ppm represented the β-phosphate of the newly created ATP (Table I).

Calculation of Enzymatic Activity

In order to calculate the enzymatic activity of pyruvate kinase, the ^{31}P integrals and resulting fraction of either PEP or ATP were first converted to μmol of PEP or ATP using (3)) and (4):

$$\mu\text{mol PEP} = (\text{Fraction PEP}) \times (\mu\text{mol PEP used in reaction}) \quad (3)$$

$$\mu\text{mol ATP} = (\text{Fraction ATP}) \times (\mu\text{mol PEP used in reaction}) \quad (4)$$

Figure 3 shows the conversion of PEP to ATP using these calculated values for the μmol of ATP produced and the resulting decline in the μmol of PEP per minute.

To calculate units/mL of pyruvate kinase activity, the μmol ATP formed was divided per unit time and then divided by the enzyme volume (mL) as in Eq. (5):

$$\text{Units/mL PK activity} = (\mu\text{mol ATP formed})/(\text{min of rxn.})/(\text{enz. vol. mL}) \quad (5)$$

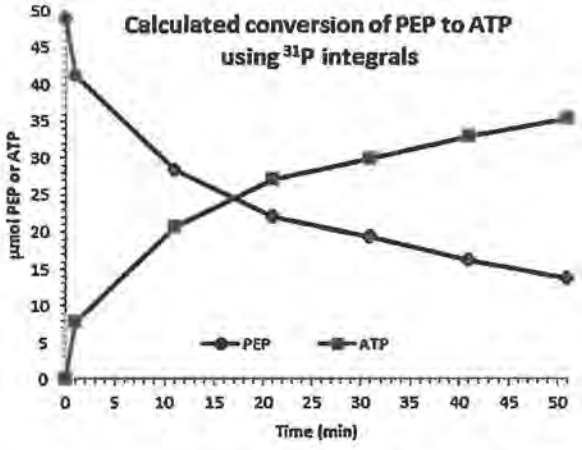

FIG 3 *Reaction progress curve of the enzymatic conversion of PEP to ATP by PK calculated using ^{31}P integrals.*

In order to demonstrate the catalytic power of an enzyme in a typical 3–4 h laboratory setting, the use of 10 U of enzyme under these reaction conditions was found to be desirable. Ideally, the calculation of enzyme units would use an "instantaneous rate" derived from the asymptotic value of the rate curve before 5% conversion of substrate to product [21, 22]. After 1 min of reaction, the reported reaction conditions had already proceeded to 16% conversion to ATP thus giving a slight underestimate of activity. Applying Eq. (4), the calculated U/mL of PK activity was 391 U/mL (7.8 μmol ATP/1 min/0.02 mL = 391 U/mL). This compares favorably to the manufacturers stated activity of 500 U/mL (21.8% difference). The reaction was also performed (data not shown) using 20 μL of a 10× diluted enzyme stock (1 U of PK instead of 10 U). This allowed for a more linear instantaneous rate below the 5% conversion threshold to be observed (1 – 31 min, $R^2 = 0.98$), and gave a calculated activity of 415 U/mL (6% difference from reported activity).

Comparison of Enzyme Activity Using ^{31}P NMR Vs. Continuous UV/Vis Assay

As an extension to the ^{31}P NMR enzymatic assay, the students were asked to compare their calculated NMR results to a standard assay utilizing an enzyme-coupled continuous spectrophotometric measurement of the disappearance of NADH at 340 nm at a temperature of 37°C [23]. This assay was modified by increasing 50 mM imidazole buffer (pH 7.5) to 1 M, thus mimicking the NMR reaction conditions. The stated activity of the commercially purchased PK was 500 U/mL, while the results of the UV/Vis assay in our hands resulted in a calculated activity of 482 U/mL (3.6% difference from reported activity). Thus, the ^{31}P NMR assay was comparable to the UV/Vis assay (391 vs. 482 U/mL, an 18.9% difference). The underestimate seen in the ^{31}P assay may be attributed to several factors: 1) the reaction temperature was only 30°C over the duration of the 24 h NMR experiment, 2) the initial asymptotic rate can be underestimated if too many units of PK are used, and 3) the acquisition time for each "data point" was approximately 45 s and represents an average ^{31}P signal over this time period.

Calculation of Equilibrium Constant

This experiment allows students to calculate an approximate equilibrium constant (K_{eq}) under nonstandard conditions for this reaction if it is allowed to proceed towards completion. This can be accomplished by either allowing the reaction to proceed in the NMR tube as described for 24 h (1440 min), or by adding additional enzyme. We chose the former approach because the chemical shift of the PEP phosphate can be affected by enzyme concentration [16]. For this calculation, it is critical to point out that the enzymatic conversion has a simple 1:1 stoichiometry (Fig. 1). Students calculated the approximate nonstandard equilibrium constant by examining the integrals of both ATP and PEP obtained after 24 h of reaction (Table I), and applying equation (6).

$$[\text{integral for ATP}]^2/[\text{integral for PEP}]^2 \quad (6)$$

Applying Eq. (6), the students calculated a K_{eq} of 992, or approximately 1000 (note: the reaction setup does not represent standard conditions of 1 M substrates, 25°C, and 1 atm of pressure). The calculated value is significantly below the reported value of 3.2×10^5 however, as noted, this value is determined under standard conditions in a calorimeter. This discrepancy provides an opportunity to discuss the differences between actual cellular concentrations of metabolites, typically in the micro- to millimolar range versus those used under standard conditions of 1M. If additional reaction time or additional enzyme was provided, the calculated K_{eq} from this experiment may approach that reported by Nageswara Rao et al. ($\sim 3 \times 10^4$) using ^{31}P NMR [16].

Conclusion

For the successful implementation of this experiment in a typical 4 h biochemistry laboratory period, several factors should be considered. First, given the limitations of NMR time and data acquisition, no more than 3 or 4 student groups could perform this experiment in the allotted time. Second, minor differences (less than 5%) in the initial rate and K_m calculations were observed between groups. These differences were mainly due to weighing initial starting materials (PEP and ADP) as well as potential pipetting differences between groups. By using the same stock solutions (i.e., enzyme, buffer, $MgCl_2$, etc.) for all student groups, results were more consistent. Finally, it should be stressed to students that the main goal of this experiment is to demonstrate the formation of ATP over time using ^{31}P NMR, and if quantitative results are required, additional measurements would be needed.

This experiment allows students to directly assay enzymatic activity through the use of ^{31}P NMR and highlights the use of "alternative nuclei" in NMR experiments. The particular enzyme studied, pyruvate kinase, is an excellent choice to study by ^{31}P NMR mainly due to the clear separation of spectral signal, however, one could imagine other interesting systems worthy of exploration in the undergraduate biochemistry laboratory [17].

Acknowledgments

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where available using the appendix cover sheet to identify how the evidence supports the relevant criteria or prompt.

PART 2: Degree-Level Review

Degree Program:

Biology

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

1. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

The learning outcomes for students in the Biology, B.S. program, including the Pre-med and Pre-vet concentration are as follows;

1) Student will thoroughly research and synthesize the primary literature for information relevant to a current scientific investigation.
2) Students will design and conduct a scientific investigation of a testable hypothesis or methodology using appropriate tools and techniques.
3) Students will effectively communicate the results or outcomes of their scientific investigation in multiple formats.
4) Students will engage in professional activities related to the study of biological and interdisciplinary sciences.
5) Graduates of the Biology, B.S. program, including the Pre-med and Pre-vet concentration will find gainful employment or go on to graduate and or professional school and enjoy rewarding careers.

Adjustments have been made to the initial goals set during the 2014-2015 AY as student performance continues to be evaluated. In some cases it has been determined that the goals were set too high or too low, and these findings are described in the "use of results" and how they pertain to corresponding learning outcome.

Please see the attached 4-column program assessment report for evidence of support.

2. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

The results from the most recent 2017-2018 AY assessment were satisfactory but our procedural methods can be improved upon, specifically through minor changes that can be made to the program seminar series. For instance, an exit survey can be created and distributed to the students completing BIOL199, BIOL299, BIOL399, and BIOL499 which would include standard course evaluation questions but also questions directed to our program assessment procedures. As these procedures for several learning outcomes are designed now, the BIOL399 and BIOL499 rubrics and their itemized scores are required to fulfill their evaluation. This can be simplified by building assessment questions into the grading rubrics for those courses and more directly generate useable data, eliminating the gathering, processing and/or transferring of data that would otherwise be necessary.

We maintain the curricula of the Biology, B.S. program, including the Pre-med and Pre-vet concentrations, to meet the requirements of the graduate and professional programs to which our students apply. By staying current on admissions exam and program requirements, as well as the recommendation made by admissions committees, the goals we've set for our graduate's success continue to be met.

Quality, Resources and Support (CC 3.A)

3. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

The learning goals mapping to student learning outcomes (SLOs) have been completed and are available on TracDat mapping for the Program (CoSE) – Biology BS. In addition to these designated SLOs, curriculum mapping of the common core requirements, where designations of 'Awareness', Basic Knowledge', and 'Comprehension' are assigned, are as follows;

BIOL131 - General Biology: Cells - (AWARENESS)
BIOL132 - General Biology: Organisms - (AWARENESS)
BIOL199 - Freshman Seminar - (AWARENESS)
BIOL220 - Genetics - (BASIC KNOWLEDGE)
BIOL250 - Quantitative Biology - (BASIC KNOWLEDGE)
BIOL280 - Biometrics - (BASIC KNOWLEDGE)
BIOL299 - Sophomore Seminar - (BASIC KNOWLEDGE)
BIOL337 - General Ecology - (COMPREHENSIVE)
BIOL399 - Junior Seminar - (COMPREHENSIVE)
BIOL495 - Senior Project - (COMPREHENSIVE)
BIOL499 - Senior Seminar - (COMPREHENSIVE)
CHEM115- General Chemistry I - (AWARENESS)
CHEM116 -General Chemistry II- (AWARENESS)

CHEM225-Organic Chemistry I - (BASIC KNOWLEDGE)

In addition, for pre-med and pre-vet concentrations;
CHEM326-Organic Chemistry II - (BASIC KNOWLEDGE)
CHEM351-Biochemistry I - (COMPREHENSIVE)

Please see the attached degree audits for the programs as evidence of support.

Intellectual Inquiry (CC 3.B).

4. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Dr. Zimmerman *has been working with a number of colleagues from around the state on a 6-year, multimillion dollar grant funded by USDA examining barriers to food access in Michigan. The project, called the Food Access in Michigan Study (www.faimproject.org) , recently wrapped up the funded portion of the work, we are now in manuscript preparation phase. The research team consists of scientists at UM-Ann Arbor (lead), UM-Flint, MSU, Grand Valley State U, U of Wisconsin and LSSU. Four LSSU students were hired as undergrad research assistants, one of which developed a spin-off from the project as her senior project (and who is now finishing up a MS program related to community health).*

From 2009 through 2018 ***Dr. Garvon*** *has secured external grant funding to hire students as Great Lakes Piping Plover monitors for 12 weeks in the summer. Students attend USF&WS training and then are responsible for collecting data regarding arrival at nesting sites, observed mating behavior and pair formation, nest establishment, incubation by both parents, hatching of chicks, development and fledging of chicks, and and mortality events throughout the process. Student monitors are required to report data weekly to the USF&WS Plover recovery coordinator, with captive rearing staff in the case of a parental mortality, with University of Minnesota personnel to coordinate banding, and in a final written report of the season's activities. Overall, during the course of continued funding 43 LSSU students have been hired as monitors. Many students have collected extra data while monitoring and used it for their senior thesis projects, resulting in 4 poster presentations at the Midwest Fish and Wildlife Conference in 2016. The first manuscript from this work is to be submitted in November of 2018.*

Flanagan, T. and J. Garvon. 2016. Invertebrate abundance near Piping Plover nests in the eastern Upper Peninsula of Michigan. 76th Midwest Fish and Wildlife Conference, Grand Rapids, MI, USA.

Kane, M. and J. Garvon. 2016. Effect of incubation investment on fledging rate of Piping Plovers. 76th Midwest Fish and Wildlife Conference, Grand Rapids, MI, USA.

Northuis, J. and J. Garvon. 2016. Effects of parental disturbance during incubation on fledging success of Piping Plovers. 76th Midwest Fish and Wildlife Conference, Grand Rapids, MI, USA.

Peters, G.and J. Garvon. 2016. Use of cabanas by Piping Plover chicks after hatching. 76th Midwest Fish and Wildlife Conference, Grand Rapids, MI, USA.

***Dr. Ranson Olson** and colleagues from Bowling Green State University have developed a model for researching the toxicity of perfluoylalkyl substrates (PFASs). This collaboration continues to provide student research opportunities and presentation in professional forums.*

Student Thesis Projects

Renee Resendes. 2018. PFAS Effects on the Development of Zebrafish.

Nicholas Hansen. 2018 A Comparison of PFAS Effects on ATP Production in Rhodobacter sphaeroides and Saccharomyces cerevisiae.

Student Presentations

Mulroney E, and B Ranson-Olson. 2015. Toxicity Mechanisms of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) on Rhodobacter sphaeroides. Michigan branch of the American Society for Microbiology, Eastern Michigan University.

Mulroney E, and B Ranson-Olson. 2014. Effects of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) on Rhodobacter sphaeroides Enzyme Activity. Michigan branch of the American Society for Microbiology, Davenport University.*
**winner best in state undergraduate poster presentation*

*Since joining the Faculty in Fall 2015, **Dr. Kolomyjec** has provided high impact research experience to undergraduate biology students in the realm of genetics. Major research initiatives have included the following:*

I. ***Draft Genome of Cladonia rangiferina** – Over the summer of 2016, with the assistance of undergraduate research student Ian Mangold, we established an ongoing axenic culture of the Cladonia rangiferina mycobiont (the fungal side of the lichen symbiosis). From that tissue culture, genomic DNA was isolated for de novo sequencing on an Illumina MiSeq Next Generation Sequencing platform. With the assistance of Amanda Charbonneau (Ph.D. Candidate, Michigan State University) that raw sequence data (~2.83Gbp) was assembled into a draft genome assembly (~38Mbp). This unpublished genome data has been used by Ian Mangold to develop a set of 16 polymorphic microsatellite DNA marks for population genetic studies on the species.*

II. ***Analyzing the microbiome of the lichen Cladonia rangiferina** – As a senior research and honors research project, undergraduate student Heather Gregg has been collecting and analyzing the microbiome of the grey reindeer lichen (Cladonia rangiferina). Heather has managed to utilize surface swabbing to isolate microbial DNA for 16s amplicon sequencing from the lichen and*

immediate substrate (soil) across several different habitat types. Her project is still generating data but the 1st five metagenomes that we have looked at are showing some interesting trends. Each swab is generating between 128,000 and 165,000 sequences after pair-end joining and quality control. After dereplication and OTU (operational taxonomic unit) clustering, we are getting approximately 800-1,700 OTUs per sample with a high level of difference between lichen and substrate.

III. ***Comparing the microbiome and necrobiome of the freshwater sponge Ephydatia muelleri*** *– For this project one of Dr. Kolomyjec's undergraduate research students, Rebekka was interested in looking at the complete microbiome (bacteria, fungal and non-fungal eukaryotic communities) of E. muelleri. The discovery of a moribund specimen while sampling lead to the comparison of the microbiome of the living portion of the sponge with the necrobiome of another section portion that had recently died back and was in the early stages of decomposition in order to look at perimortem changes in microbial composition.*

*For the past several years, **Dr. Li** awarded several research grants and also involved LSSU students and faculties in the researches and international collaborations which greatly enhanced the connection with China institutions and recruiting several Chinese students to LSSU.*

1) 2016-2017 Chinese Natural Science Fund for Oversea Researchers: Involvement of phagocytic B cells against infection in marine fish. RMB, 200,000. PI. (Co-PI, Dr. Li Sun from Institute of Oceanology, Chinese Academy of Sciences, China; by using the grants, I invited Dr. Garvon to visit QINGDAO China in July 2018 for future collaboration).

2) 2015-2016 Chinese Natural Science Fund for "Protective Immunity of Inactivated Edwarsiella tarda Bacterins in Marie Fish. RMB 300,000. Co-PI, (PI, Dr. Guoshi Xie, Yellow Sea Fishery Research Institute, Qingdao, China).

3) 2015-2017 Bureau of Indian Affairs-Great Lakes Restoration Initiative Funds (BIA-GLRIF). Monitoring fish movement and fish condition in tributaries of Whitefish Bay. $142,964. Co-PI ($ 80,033 for LSSU, PI, Dr. Ashley Moerke.). The grant included a couple LSSU students, Lucas Bradburn, Fish Health major

4) 2014-2015 Contract from Algal Scientific Company, Effect of Dietary beta-glucan Derived from Algae on Growth Performance, Disease Resistance and Immune Response in Atlantic salmon. $20,746. PI. (Co-PI, Dr. Evans from LSSU). Aslo included a visiting scholar Dr. Jianzhong Gao from Shanghai Ocean University; several LSSU students, Jing Zhang, Hui Zhao; Conner Workentine; Lucas Bradburn; Jenay Andrews

5) 2014-2016 (extended to 8/2017) Great Lakes Fishery Trust. Re-Emergence of Epizootic Epitheliotropic Disease Virus: Potential Effects and Development of Improved Diagnostics &Control Measures. $446,492. Co-PI. (PI, Dr. Mohamed Faisal from

Michigan State University, East Lansing, MI). ($65,299 for LSSU) ; Included the LSSU students Lucas Bradburn; Alysha Briglio; Ryan Renz

6) 2014 The Great Lakes Council of the Federation of Fly fishers Research Grant, $400 (PI). Included LSSU student Tyler Jackson

7) 2014-2018 Key Project from Chinese Natural Science Fund for the study "Immuno-escape Mechanisms of Edwarsiella tarda in Turbot". Chinese Yuan (RMB) 3,000,000.00, Co-PI. (PI, Dr. Li Sun, from Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China)

8) 2011-2014 Chinese Natural Science Fund for Application of Immuno-stimulants against Fish Diseases. RMB 500,000. Co-PI, (PI, Dr. Xiuhua Wang, Yellow Sea Fishery Research Institute, Qingdao, China).

***Dr. Marth Hutchens**, in a collaborative project with Dr. Adam Mosey of Chemistry, has performed projects with student Celina Malcolm, an MLS major, since the spring of 2017. Celina presented a poster at the West Michigan Regional Undergraduate Science Research conference at the Van Andel Institute in Fall 2017. The title of the poster was "Anti-MRSA and Anti-Biofilm Activity of 3,4-Dihydroquinazolines."*

Mark Santoyo (also an MLS major) did his senior thesis project as a collaboration with Christopher Savich (one of Dr. Mosey's mentees), they won a Fund for LSSU grant for their proposal "Synthesis and testing of novel substituted 3,4-Dihydroquinazolines for anti-cancer properties" in spring of 2017.

Kory Korcal (MLS major) presented a poster at the Fall 2016 American Society for Microbiology--Michigan meeting "Korcal KR, Wall TJ, Magyar CL, Mosey RA, Hutchens MA. 2016. Biofilm Inhibition and Destruction Using Newly Synthesized Compounds. Presented at 2016 Fall Meeting of the Michigan Branch of the American Society for Microbiology, October 21-22, 2016."

Carissa Paiz (Biology major) presented a poster, "Pathogenic Bacteria S. aureus on the Footwear of Healthcare Workers" at the Spring 2016 American Society for Microbiology--Michigan meeting; this poster won the Best Undergraduate Poster award for that meeting.

***Dr. Barbara I. Evans** has established a number of research projects involving LSSU students, and has received local and national funding to support the projects and hire students.*

1. ***Aquaculture:***

2016-2017 ($39907.16, USDA-NIFA) "Youth Education In Aquaculture (YEA)" B.I. Evans (grant chairperson), and C. Smith. This is an ongoing project that aims to create an educated workforce for the emerging US aquaculture industry, but also promotes interest and resources for Science, Technology, Engineering and Mathematics (STEM) education. The project was initiated in 2015 in collaboration with Dr. Christopher Smith (LSSU Computer Science) and funded through the Michigan STEM Partnership to develop a competition called the Aquaculture Automation

Challenge. LSSU undergraduates were an integral part of design and facilitation of the competition, with Kacie Ferguson acting as project director for her experiential learning senior thesis for Conservation Biology. Evans and Smith next received funding from the USDA-NIFA to develop a website (www.ncrac-yea.org) to integrate aquaculture education throughout Michigan and Wisconsin.

https://www.ncrac.org/projects/funded-project-25-youth-education-aquaculture-yea

-We employed 4 LSSU students on this grant

Taylor Barnum, an LSSU computer science student worked with Dr. Smith to develop the website. The project has now expanded and is currently funded by USDA-NIFA to include twelve states throughout the midwestern United States. https://www.ncrac.org/projects/educating-workforce-aquaculture-industry-matching-skill-needs-aquaculture-industry-us

2017-2019 ($188,036, USDA-NIFA) "Educating a Workforce for the Aquaculture Industry: Matching Skill Needs of the Aquaculture Industry with US Career and Technical Education (CTE)", B.I. Evans (grant chairperson overseeing collaboration between LSSU, University Wisconsin Steven's Point and Iowa State University), C. Hartleb, H. Helal, K. Simmons, A. Pattillo/M. Lambert.

LSSU is taking the lead on this collaboration with University of Wisconsin Steven's Point and Iowa State University. Although now both LSSU graduates, Ferguson and Barnum, continue to contribute to this project, and numerous other LSSU undergraduates have been hired on the project.

-We have employed 3 LSSU undergraduates, and 3 LSSU graduates on this grant.

2) Genetic Testing:

2015 ($1500, Funds for LSSU) proposal "Preventing Symptoms of Iron Loading Disease with Early Diagnosis" with student Lucas Meehan. This is an ongoing project with War Memorial Hospital to survey the local population for hereditary hemachromatosis by identifying mutations in the HFe gene. Hemachromatosis, or iron overload in the body, is an underdiagnosed potentially fatal condition that is easy to treat through therapeutic phlebotomy or blood donation. Kaila Golanka developed the PCR test for her LSSU Biology senior thesis project, and LSSU students Lucan Meehan (LSSU Athletic Training, but now an MSU medical student) and Heather Gregg (Biology pre-med senior) have volunteered their time to process the samples. The project was initially funded by a grant from the LSSU foundation Funds for LSSU. To date we have results for over 200 individuals. Note the gene analyzer used for this study was obtained through an NSF grant to Dr. Evans. "Acquisition of DNA Sequencer for Undergraduate Research/Training" (P.I. Evans; co PI's Hansen, Kirkpatrick) Funded 2001-2004 (NSF-0116086) $133,200.)

3) Histology:

Retinal Development of the Larval Muskellunge (Esox masquinongy)

Considerable variation exists in the developmental timetable of different fish species. Some hatch with a typical adult retina while others delay the maturation of the retina for weeks to months after hatching. Preliminary histological examination of a juvenile muskellunge specimen (provided by Dr. Kevin Kapuscinski) revealed a unique cone photoreceptor arrangement, but nothing was found in the literature about the development of this retinal morphology or it's ecological significance. During the summer of 2018, muskellunge larvae were collected from 1 day through 35 days post hatch, through collaboration with Martha VanAmberg at the MDNR Wolf Lake State Fish Hatchery. The samples are being processed and thin sectioned by the students in this semester's BIOL433 Histology class. Results so far indicate that at hatching, the photoreceptors have not yet fully differentiated, but at 35 days post hatch the retina looks functional, but there are still few rod photoreceptors. Throughout the Fall 2018 semester, the class will work up the results and collaborate with Dr. Evans on a manuscript for a peer-reviewed publication.

Spring 2018 Classroom experiences:

Taylor Miller Biology Pre-Vet (senior thesis project mentored by Dr. Barbara Evans): Taylor was interested in the how pets may receive emotional support from their owners. Her project was titled : "Does Human Companionship Reduce Canine Heart Rate and Visual Stress Behaviors?" and she was recognized with the best poster award for indoor research for Spring 2018

Nicholas Moorman Fisheries (senior thesis project mentored by Dr. Barbara Evans): Nick was interested in determining if the ARL Atlantic salmon genotypes had diverged from the sources population in Maine. He travelled to the Maine hatchery to obtain samples, and did a genetic study: Evaluation of Genetic Drift in Atlantic salmon (Salmo salar) between the St.Marys River, Mi and West Grand Lake, ME Populations. Nick received URC funding for his project, and presented his results S2018.

Heather Gregg Biology Pre-med (Independent study project mentored by Dr. Barbara Evans. Heather worked to add Native American subjects to the database for genetic screening of hereditary hemachromatosis.

Please see the attached BIOL499 student research abstracts from the fall 2017 and spring 2018 symposiums as additional evidence of support.

Assessment: Program Four Column

Program report 22oct2018

Program (CoSE) - Biology BS

Assessment Contact: Dr. Jason Garvon

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Scientific Literature - Students in the Biology, B.S. program, including the Pre-med and Pre-vet concentration, will thoroughly research and synthesize the primary literature for information relevant to a current scientific investigation. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2014	**Direct - Capstone Project - including undergraduate research -** As part of their undergraduate research project, Biology students are required to use sources from the primary literature to communicate the scope and rationale of their project. Rubrics are used to evaluate this requirement for the senior thesis paper. **Criteria Target:** All Biology students will meet minimum satisfactory requirements (average 12/20 for he Introduction sections of the senior thesis paper rubric). At least 50% of the students will demonstrate exemplary scores(18 of 20) for the 'Introduction' section of the thesis rubric). **High Impact Program Practices 1:** Undergraduate Research **High Impact Program Practices 2:** Capstone Course(s), Projects	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of biology students met the minimum satisfactory requirements for the Introduction section of the senior thesis paper for fall 2016 and spring 2017 semesters. 71% of seniors for fall 2016 and 80% of seniors for spring 2017 received an exemplary score on the Introduction section of their research paper. (08/16/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
	Direct - Capstone Project - including undergraduate research - As part of their undergraduate research project, biology students are	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 88% of biology students received a satisfactory score score on the introduction and literature cited section of their	**Use of Result:** Goal met. Reassess AY 2018-2019. (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	required to use sources from the primary literature to communicate the scope and rationale of their project. Rubrics are used to evaluate this requirement for the poster, thesis paper, and oral presentation. (Active) **Criteria Target:** 75% of biology seniors will receive a satisfactory score on the introduction and literature cited section of his/her senior research paper. **High Impact Program Practices 1:** Undergraduate Research **High Impact Program Practices 2:** Capstone Course(s), Projects	senior research paper for fall 2017 and spring 2018 semesters. 14% of seniors for fall 2017 and 31% of seniors for spring 2018 received an exemplary score on the Introduction section of their research paper. (08/23/2018) **Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of students, both fall 2016 semester and spring 2017 semester, received a satisfactory score score on the on the introduction and literature cited section of their senior research paper. (08/16/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
	Direct - Capstone Project - including undergraduate research - As part of their undergraduate research project, biology students are expected to properly cite sources from the primary literature. Rubrics are used to evaluate this requirement for both the poster and written paper. **Criteria Target:** 75% of students who turn in a senior research paper will receive a satisfactory score on the introduction, discussion and literature cited sections of the paper. **High Impact Program Practices 1:** Writing-Intensive Course(s) **High Impact Program Practices 2:** Capstone Course(s), Projects	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 100% of students, for fall 2016 and spring 2017 semesters, who turned in a senior research paper received a satisfactory score on properly citing sources from the primary literature in their final research paper. (08/16/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
Scientific Investigation - Students in the Biology, B.S. program, including the Pre-medical and Pre-veterinary concentration, will design and	**Direct - Capstone Project - including undergraduate research -** All biology students, including pre-medical and pre-veterinary, are	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of the students, both fall 2017 and spring 2018 semesters, met the minimum satisfactory requirement over	**Use of Result:** The percentage of students that we expected to receive an exemplary score on the Methods, Results and Discussion

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
conduct a scientific investigation of a testable hypothesis or methodology using appropriate tools and techniques. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2014 **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) **Institutional Learning:** ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem.	required to conduct an independent and original research project under the guidance of a faculty mentor. The mentor evaluates the scientific merit of the project, as presented in written thesis, using the 'Methods', 'Results', and 'Discussion' sections of a grading rubric. **Criteria Target:** All students will meet minimum satisfactory requirements over the relevant sections of the rubric. At least 25% of the students will achieve exemplary performance over the relevant sections of the rubric. **High Impact Program Practices 1:** Undergraduate Research **High Impact Program Practices 2:** Capstone Course(s), Projects	the relevant sections of the rubic. 71% of the students during the fall 2017 semester and 55% of the students during the spring 2018 semester achieved exemplary performance of the relevant sections of the rubric. (08/23/2018)	sections of the senior thesis paper was lowered from 50% to 25% in 2015. It then became our goal to set that back up to 50%, and the 2017-2018 results support that action. Goal met. (08/23/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of the students, both fall 2016 and spring 2017 semesters, met the minimum satisfactory requirement over the relevant sections of the rubic. 71% of the students during the fall 2016 semester and 80% of the students during the spring 2017 semester achieved exemplary performance of the relevant sections of the rubric. (08/16/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
Communication - Students in the Biology, B.S. program, including the Pre-med and Pre-vet concentration, will effectively communicate the results or outcomes of their scientific investigation in multiple formats. **Goal Status:** Active **Goal Category:** Student Learning **Start Date:** 05/01/2014 **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations.	**Direct - Presentation, Performance -** All biology students, including pre-med and pre-vet are required to communicate the results of an independent research project in the form of a poster presentation. This includes a 2-hour Q&A session, open to the public, with the students in attendance. Posters are evaluated by multiple faculty using a rubric. **Criteria Target:** 100% of biology students who present a poster will receive satisfactory scores on the standardized poster rubric. 25% of biology students who present a poster will receive exemplary scores on the standardized poster rubric. **High Impact Program Practices 1:** Undergraduate Research **High Impact Program Practices 2:**	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students received a satisfactory score on their poster presentations for the fall 2017 and spring 2018 semesters. 50% of the students during the fall 2017 semester and 67% of the students during the spring 2018 semester received an exemplary score on their poster presentations. (08/23/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students received a satisfactory score on their poster presentations for the fall 2016 and spring 2017 semesters. 43% of the students during the fall 2016 semester and 80% of the students during the spring 2017 semester received an exemplary score on their poster presentations during for the spring 2017 semester. (08/21/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Capstone Course(s), Projects **Direct - Presentation, Performance -** All biology students, including pre-medical and pre-veterinary, are required to communicate the results of an independent research project in the form of a PowerPoint presentation at a research symposium held at the end of each semester. Presentations are evaluated by multiple faculty using a rubric. **Criteria Target:** 100% of the students presenting a PowerPoint presentation at a departmental research symposium will receive a satisfactory score based on a standardized grading rubric. 25% of the students will receive an exemplary score. **High Impact Program Practices 1:** Capstone Course(s), Projects **High Impact Program Practices 2:** Undergraduate Research	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students for the fall 2017 and spring 2018 semesters received a satisfactory score on their Power Point presentations at the research symposium for the spring 2017 semester. 31% of the students for the fall 2017 semester and 59% of students for the spring 2018 semester received an exemplary score on their Power Point presentations. (08/27/2018)	**Use of Result:** Goal met. Reassess following year. (08/27/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students for the fall 2016 and spring 2017 semesters received a satisfactory score on their Power Point presentations at the research symposium for the spring 2017 semester. 86% of the students for the fall 2016 semester and 60% of students for the spring 2017 semester received an exemplary score on their Power Point presentations. (08/21/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
	Direct - Capstone Project - including undergraduate research - All biology students, Including pre-medical and pre-veterinary, are required to communicate the results of an independent research project in the form of a written paper. The paper is evaluated by each student's faculty mentor using a rubric. **Criteria Target:** 100% of students will receive a satisfactory score on their senior thesis paper. 25% of students will receive an exemplary score on their senior thesis paper.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students received a satisfactory score on their senior thesis paper during the fall 2017 and spring 2018 semesters. 35% of students during the fall 2017 semester and 55% of the students during the spring 2018 semester received an exemplary score on their thesis. (08/27/2018)	**Use of Result:** Goal met. Reassess following year. (08/27/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students received a satisfactory score on their senior thesis paper during the fall 2016 and spring 2017 semesters. 43% of students during the fall 2016 semester and 60% of the students during the spring 2017 semester received an exemplary score on their thesis. (08/21/2018)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	High Impact Program Practices 1: Undergraduate Research **High Impact Program Practices 2:** Capstone Course(s), Projects		
Professionalism - Students in the Biology, B.S. program, including the Pre-med and Pre-vet concentration, will engage in professional activities related to the study of biological sciences. **Goal Status:** Active **Start Date:** 05/01/2014	**Indirect - Report/Audit - Internal -** The department chair will report yearly on the professional activities of students in the biology program. **Criteria Target:** Ten students in the biology program will engage in some sort of professional activity each year. Examples of professional include, but are not limited to research meetings, graduate or professional school visit, workshop or symposium. **High Impact Program Practices 1:** Not applicable to this outcome **High Impact Program Practices 2:** Not applicable to this outcome	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Two pre-professional students attended the 2018 Michigan American Society for Clinical Laboratory Science meeting, three visited state medical schools (MSU and CMU), one interested in graduate programs visited MTU, and three attended a round-table discussion and continuing medical education event at War Memorial Hospital in November of 2017. Also, two students participated through the year in a science-based research project in collaboration with physicians and patients of War Memorial Hospital. (06/01/2018)	**Use of Result:** Goal met. Reevaluate AY 2018-2019. (08/23/2018)
Post Graduation - Graduates of the Biology, B.S. program will find gainful employment or go on to graduate and or professional school and enjoy rewarding careers. **Goal Status:** Active **Goal Category:** Operational Goal, not related to student learning **Start Date:** 06/01/2014	**Other Findings**	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 2018 LSSU Graduate Survey Responses - Biology. 19 Student responses. Grad School: 47% Employment: 26% Employment outside: 11% Unemployed: 11% Internship: 5% Total: 100% (08/23/2018)	**Use of Result:** Small data set (n=19). Will continue to survey graduates and increase the robustness of these survey results. (08/23/2018)
Post Graduation - Pre-Med and Pre-Vet concentrations - Graduates of the Biology B.S. Pre-Med and Pre-Vet concentrations will go on to graduate and or professional school and enjoy rewarding careers. **Goal Status:** Active	**Other Findings**	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Summary (1996-2018) of the number of biology graduates who matriculated in the following professional and graduate schools. A full report including names and school attended is maintained by pre-professional advisers Britt Ranson Olson and Martha Hutchens.	**Use of Result:** 2017-2018 Graduates from the pre-professional concentrations in the Biology program were successful in their application to both professional and graduate science programs. Goal met. Will evaluate

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Other Findings	Medical School: 38 Dental School: 16 Vet School: 9 Other health professions: 24 (includes chiropractic, optometry, pharmacy, podiatry, physician assistant) Grad School: 21 Other: 4 (08/23/2018)	AY 2018-2019. (08/23/2018)

Pre-Professional Society

LAKE SUPERIOR STATE UNIVERSITY

Pre-Professional Society

DEGREE AUDIT - B.S. BIOLOGY

PreVet Concentration

Name _____

ID _____

GPA _____ Credits _____

Major _____ 30 of last 60 _____

Gen Ed _____ 50% of 300 / 400 _____

VERIFICATION & APPROVAL

Advisor _____ Date _____

Minor _____ Date _____

Chair _____ Date _____

Registrar _____ Date _____

Effective Fall 2013

BIOLOGY (55)

Course	Name	Sem	Credit	Grade
BIOL131	General Biology I		4	
BIOL132	General Biology II		4	
BIOL199	Freshman Seminar		1	
BIOL220	Genetics		4	
Select...	Quantitative Elective		3	
BIOL280	Biostatistics		3	
BIOL299	Sophomore Seminar		1	
BIOL337	General Ecology		3	
BIOL399	Junior Seminar		1	
BIOL495	Senior Project		2	
BIOL499	Senior Seminar		1	
Select...	Taxonomy Elective		3-4	
Select...	Physiology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	

ADDITIONAL REQUIREMENTS (37)

Course	Name	Sem	Credit	Grade
CHEM115	General Chemistry I		5	
CHEM116	General Chemistry II		5	
CHEM225	Organic Chemistry I		4	
CHEM226	Organic Chemistry II		4	
CHEM351	Intro Biochemistry		4	
MATH111	College Algebra		3	
MATH112	Calc. for Bus & Life Sci		4	
PHYS221	Princ of Physics I		4	
PHYS222	Princ of Physics II		4	

GENERAL EDUCATION (25)

Course	Name	Sem	Credit	Grade
COMM101	Fund. Of Speech Comm.		3	
ENGL110	First Year Composition I		3	
ENGL111	First Year Composition II		3	
HUMN251	Humanities I		4	
Select...	Humanities Elective		3-4	
Select...	Social Science Elective		3-4	
Select...	Social Science Elective		3-4	
Select...	Diversity Elective		3-4	

FREE ELECTIVES (8)

Course	Name	Sem	Credit	Grade

Pre-Professional Society

LAKE SUPERIOR STATE UNIVERSITY

Pre-Professional Society

DEGREE AUDIT - B.S. BIOLOGY

PreMed Concentration

Name _____

ID _____

GPA _____ Credits _____

Major _____ 30 of last 60 _____

Gen Ed _____ 50% of 300 / 400 _____

VERIFICATION & APPROVAL

Advisor _____ Date _____

Minor _____ Date _____

Chair _____ Date _____

Registrar _____ Date _____

Effective Fall 2013

BIOLOGY (55)

Course	Name	Sem	Credit	Grade
BIOL131	General Biology I		4	
BIOL132	General Biology II		4	
BIOL199	Freshman Seminar		1	
BIOL220	Genetics		4	
Select...	Quantitative Elective		3	
BIOL280	Biostatistics		3	
BIOL299	Sophomore Seminar		1	
BIOL337	General Ecology		3	
BIOL399	Junior Seminar		1	
BIOL495	Senior Project		2	
BIOL499	Senior Seminar		1	
Select...	Taxonomy Elective		3-4	
Select...	Physiology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	

ADDITIONAL REQUIREMENTS (37)

Course	Name	Sem	Credit	Grade
CHEM115	General Chemistry I		5	
CHEM116	General Chemistry II		5	
CHEM225	Organic Chemistry I		4	
CHEM226	Organic Chemistry II		4	
CHEM351	Indtro Biochemistry		4	
MATH111	College Algebra		3	
MATH112	Calc. for Bus & Life Sci		4	
PHYS221	Princ of Physics I		4	
PHYS222	Princ ofPhysics II		4	

GENERAL EDUCATION (27)

Course	Name	Sem	Credit	Grade
COMM101	Fund. Of Speech Comm.		3	
ENGL110	First Year Composition I		3	
ENGL111	First Year Composition II		3	
HUMN251	Humanities I		4	
Select...	Humanities Elective		3-4	
PSYC101	Intro to Psychology		4	
SOCY101	Intro to Sociology		4	
HLTH328	Multicult Appr Hlth Care		3	

FREE ELECTIVES (6)

Course	Name	Sem	Credit	Grade

LAKE SUPERIOR STATE UNIVERSITY

DEGREE AUDIT - B.S. BIOLOGY

Name _____

ID _____

GPA _____ Credits _____

Major _____ 30 of last 60 _____

Gen Ed _____ 50% of 300 / 400 _____

VERIFICATION & APPROVAL

Advisor _____ Date _____

Minor _____ Date _____

Chair _____ Date _____

Registrar _____ Date _____

Effective Fall 2013

BIOLOGY (55)

Course	Name	Sem	Credit	Grade
BIOL131	General Biology I		4	
BIOL132	General Biology II		4	
BIOL199	Freshman Seminar		1	
BIOL220	Genetics		4	
Select...	Quantitative Elective		3	
BIOL280	Biostatistics		3	
BIOL299	Sophomore Seminar		1	
BIOL337	General Ecology		3	
BIOL399	Junior Seminar		1	
BIOL495	Senior Project		2	
BIOL499	Senior Seminar		1	
Select...	Taxonomy Elective		3-4	
Select...	Physiology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	
Select...	Biology Elective		3-4	

ADDITIONAL REQUIREMENTS (25)

Course	Name	Sem	Credit	Grade
CHEM115	General Chemistry I		5	
CHEM116	General Chemistry II		5	
CHEM225	Organic Chemistry I		4	
MATH111	College Algebra		3	
MATH112	Calc. for Bus & Life Sci		4	
Select...	Phys Sci Elective		4	

GENERAL EDUCATION (25)

Course	Name	Sem	Credit	Grade
COMM101	Fund. Of Speech Comm.		3	
ENGL110	First Year Composition I		3	
ENGL111	First Year Composition II		3	
HUMN251	Humanities I		4	
Select...	Humanities Elective		3-4	
Select...	Social Science Elective		3-4	
Select...	Social Science Elective		3-4	
Select...	Diversity Elective		3-4	

FREE ELECTIVES (20)

Course	Name	Sem	Credit	Grade

2017 Fall Semester School of Biological Sciences Senior Research Symposium

The Effect of Sleep on Cognitive Function: A Meta-Analysis

Jasmine Hitt
School of Biological Sciences, Lake Superior State University

ABSTRACT: Sleep provides many restorative, beneficial processes to the body. Tissues and cells are repaired, as well information processing. There are many sleep studies out there looking at how exactly sleep affects the human body and the brain. There is a wealth of data and knowledge showing what the relationship may be. Yet, there is a lot of disagreement among researchers, specifically about how data is interpreted. A meta analysis was executed to interpret data from prior studies in order to view the relationship. This research shows thatsleep deprivation: partial, short term, and long term all have adverse effects on a person's ability to focus, learn, process and memorize new information. It was also found that Rapid Eye Movement sleep has the biggest impact on these functions, so disrupting this process not only increases risk for heart disease but also decreases functions significantly. Even in partial sleep deprivation it was found that these processes are hindered.

Characterization of 16 Polymorphic Microsatellite DNA Markers for the Grey Reindeer Lichen (*Cladonia rangiferina*)

Ian Mangold
School of Biological Sciences, Lake Superior State University,
Sault Ste. Marie, MI 49783

Abstract: *Cladonia rangiferina* commonly known as Reindeer lichen, has a wide range found throughout Eastern and Northern America and Canada. However, relatively little is known about C. rangiferina or many other lichen's population structure. Additionally, the proper tools must be developed for future studies to be done. For future population studies to be completed, both microsatellites markers and the primers that amplify them will need to be identified and optimized. To that end I have optimized, tested and analyzed 15 primers that express polymorphism in *C. rangiferina*.

Microbes in Honey

Maranda Semig
School of Biological Sciences, Lake Superior State University
Sault Ste. Marie, Michigan

Abstract: Honey can be used to treat small wounds and for consumption, but isn't recommended for children under one year old. This is because honey often has spores of *Clostridium botulinum*, which can be fatal. Since one bacterial species can survive in honey, even though it's a commonly-known antimicrobial agent, this paper investigates what other microbes reside in honey, and how source location, processing method, and age affect the number and types of microbes in honey. To conduct this experiment, Raw and Non-raw samples from the Metro-Detroit and Chippewa County areas were gathered and used as well as an aged sample of honey. These samples were serially diluted in sterilized water and spread on agar plates as well as incubated overnight. Colonies were counted, and unique-looking colonies were tested using various methods and were subjected to further identification testing using a variety of biochemical assays. Data analysis revealed that there were just as many potentially harmful bacteria as there were harmless. Upon performing t-tests on the colony forming units (CFU's), it could be seen that most of the bacteria was from the Chippewa County, the age of honey does not have an effect on the microbes present, and raw honey has more microbes than pure honey.

Effectiveness of Alcohol Wipes and Sunlight on Bacteria from Local Shopping Carts

Sydney Suchey

School of Biological Sciences,Lake Superior State University
Sault Ste. Marie, Michigan

Abstract: There are many bacterial species that cause human illness, including *Clostridium difficile* and *Staphylococcus aureus*; these diseases are easily transmittable throughout the public, despite them only being contractible in hospital settings until recent years. A purpose of the experiment performed was to determine whether or not these species and other bacteria were present on shopping cart handles. Another goal was to determine if alcohol wipes and sunlight eliminated any present bacteria, and, if so, how much. It was hypothesized that alcohol wipes would be more effective than sunlight. To test this, carts were randomly selected from the inside of the store, the handles were swabbed, and the swabs were placed into broth. The samples were later transferred to agar plates, which were incubated and observed for colonies. Samples were taken/made in the same matter after the cart handles were wiped and placed into sunlight. It was later determined that both the alcohol wipes and sunlight were very effective in eliminating bacteria. Limited bacterial amounts and similarities between the outcomes resulted in the inability to confidently establish which was the most successful method. *Staphylococcus aureus* was found on twelve carts and no *Clostridium difficile* was collected. Information gained from this research and experiment is important for public disease awareness and prevention.

Purification of Toxic Metalloproteinases from Western Diamondback Rattlesnake (*Crotalus atrox*) Venom

Danielle Webber
School of Biological Sciences, Lake Superior State University
Sault Ste. Marie, Michigan

ABSTRACT. There has been significant research performed to show that the North American possum (*Didelphis virginiana*) is highly resistant to enzymes called snake venom metalloproteinases in Western Diamondback rattlesnake (*Crotalus atrox*) venom due to the gene oprin. However, it is yet unknown what the connection between the oprin gene and the metalloproteinases are. The objective of this study is to discover why the oprin gene gives *Didelphis virginiana* its resistance. Crude *Crotalus atrox* venom was purified using a diethylaminoethyl column to separate the venom components into four fractions, and the activity of the fractions were tested in comparison with crude venom activity. One fraction showed significantly higher activity than the other three and will be used for further purification to isolate specific metalloproteinases in the future. The purified metalloproteinases will be combined with the oprin gene from *Didelphis virginiana* and a series of peptides to test inhibition against the enzymes. This research will provide a basis for future work into the mechanism of action between possum serum and snake venom and lead to a better understanding of inhibitors and potential antivenoms.

2018 Spring Semester School of Biological Sciences Senior Research Symposium

Assessment of Recovery after Scheduled Time off to Hospital Employees Working Night Shifts

McKenna Blyly
School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

ABSTRACT. The circadian rhythm acts as a biological "clock" for the body. Extended shift work, or shifts lasting longer than eight hours, has been associated with disrupting this rhythm, which can lead to disorder and disease. The influence of sleep on recovery after working extended night shifts was examined compared to day shift employees. Ten employees from day and night shift were assessed at bedtime after their last day of the work week, when they were presumably most tired, and again at bedtime before their first shift of the work week, when they were presumably most well-rested. At each assessment a short-term memory evaluation was administered, and salivary melatonin samples were collected. Results did not show a significant difference in melatonin concentrations between day and night shifts after the recovery period. Both groups experienced a rise in short-term memory function after treatment, with night shift participants scoring higher than day shift. These data indicate that the weekend rest period is beneficial for recovery after shift work, but the extent between types of shift work remains unclear.

The effect of the invasive Red Lionfish (*Pterois volitans*) on Caribbean fishes in natural and simulated coral reef and mangrove habitats.

Michela Coury

School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, MI

Executive Summary: Introduced around 1985, the Red Lionfish (*Pterois volitans*), native to the Indo-Pacific Ocean region, has created an ecological toll through invasion of Caribbean and Atlantic waters. Their invasion has created negative impacts on native species and is in need of further study. To determine the effects of this threat, the objectives of this study are to, determine changes in native fishes' community structure in the presence of Lionfish, and evaluate the effects of its presence on native fish behavior in simulated mangrove and coral reef habitats. The field observational study in the Ambergris Caye, Belize, classified species abundance with Lionfish presence. The behavioral study, conducted within a laboratory at Lake Superior State University, collected data on the behavior/distribution of native fish with Lionfish present. The field results indicated that abundance decreased 23.4% with the Lionfish present. In the lab study, with the Lionfish present, the Sergeant Majors (*Abudefduf saxatilis*) observed to have a notable increase in approaching and avoiding behaviors in both systems, while the Bluehead Wrasse (*Thalassoma bifasciatum*) only demonstrated a notable increase in approaching within the coral reef system. There was an overall change in distribution within both systems, both species preferred opposite sides of the tank during the treatments. Overall, the results demonstrate that with Lionfish present, there is a community structural change of the native species which can lead to behavioral changes. These findings are important in understanding means in prevention of the Lionfish invasion.

Population Genetics Study of Beaver (*Castor canadensis*) in Northern Michigan

Kati Doty
School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

Abstract: The North American beaver, *Castor canadensis*, is considered an "ecosystem engineer," known for physically altering wetlands to create unique habitats and directly impacting the diversity and abundance of other aquatic species in the area. The keystone species plays a pivotal role in ecosystem biodiversity across North America. As there has not been a significant amount of data accrued for the beaver in Michigan, the purpose of this study was to observe the population genetics of this species in the Upper and Lower Peninsulas in order to create a current census. DNA from seventeen beaver tissue samples, originating from various sample sites across the state, was extracted and amplified through polymerase chain reaction. A population genetics analysis was performed at four microsatellite loci for the species. The population assignment showed genetic variation between populations of beaver in the two peninsulas. Neutrality of microsatellites was observed to be in Hardy-Weinberg equilibrium.

The effects of glyphosate on human gastrointestinal microorganisms

Morgan L. Ferguson
School of Biological Sciences
Lake Superior State University
Sault St. Marie, Michigan

Abstract: Glyphosate is a very potent herbicide capable of killing a large spectrum of weeds and is especially effective given its ability to be used in sequence with Roundup® Ready crops. However, the amount of glyphosate being applied annually has risen to an unsustainable level and has the potential to affect both environmental and human health in previously unforeseen ways. One way in which glyphosate could affect human health is by disrupting the normal gastrointestinal (GI) microflora. The present study observed the effects of glyphosate on human GI microorganisms by exposing various bacteria isolated from human feces to varying concentrations of glyphosate. Additionally, the bacterial isolates were identified through DNA sequencing, which was isolated from each bacterium and amplified prior to sequencing. The resulting data indicates that bacterial isolates 1, 2, 4,10, 11, 15, and 16 showed no significant difference in growth due to glyphosate exposure. Isolates 3, 5, and 13, however, did show significant changes in growth, with isolate 13 being inhibited by glyphosate, and isolates 3 and 5 being stimulated by glyphosate. Why these growth patterns occurred is unknown (possibly due to genetic factors and/or glyphosate concentration). The inhibition of even one isolate indicates that glyphosate has the potential to disrupt the normal GI microflora needed for Vitamin K production and prevention of inflammatory bowel disease. The two isolates that grew better in glyphosate might be used to help break down glyphosate in the environment. Regardless of what was discovered, more research into this area is needed to understand glyphosate's effect on human GI bacteria.

Creating trail maps and improving the properties of Sarett Nature Center in Benton Harbor, MI

Juliet Golob

School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, MI

Executive Summary: Nature centers provide accessible locations for outdoor recreation activities and education. Not all preserves have access to software to create trail maps for their visitors. The goal of this project was to create maps for Brown Sanctuary and Black's Woods properties to get visitors involved in all of the outdoor opportunities that Sarett Nature Center provides. Trail maps were created using ArcGIS for both properties. These maps were then approved by the Sarett Nature Center board for accuracy and usability. Additionally, trails were cleared and marked for visibility. Brochures were then created for both sites and brochure holders were installed and stocked at both sites with the newly created maps for visitor use. These maps will now allow visitors to enjoy these locations to the best of their ability and experience what they have to offer.

Synthesis & Evaluation of Alkylamine Substituted Peptoids as Anti-Microbial Agents

Julie Harper

School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

Increasing interest in peptide and peptoids has led to research related to potential drug and anti-microbial discovery. Peptoids are derivatives of peptides containing side chains on the nitrogen instead of the alpha carbon of peptides. Previous studies have found that peptoid dimers and trimers have been effective against both gram-negative and gram-positive bacteria, and that overall, peptoids have shown to possess anti-microbial properties. The strength of peptoids to act as anti-microbial agents may be because peptoids are more well-built for diverse physiological conditions in the body, in comparison to peptides. A methodology was developed to synthesize six alkylamine substituted peptoids by solid phase synthesis. The disc diffusion assay was used to evaluate the growth inhibition of the compounds against two strains of bacteria, *E. coli and S. aureus.* Analysis and comparison of the zones of inhibition of the six compounds and the controls concluded that the phenylethylamine hexamer peptoid was the only compound to inhibit growth of bacteria, specifically *S. aureus.*

Does Human Companionship Lower Canine Heart Rate and Visual Stress Behaviors?

Taylor Miller

School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, MI

ABSTRACT: The domestic dog (*Canis lupus familiaris)* is commonly found in the average home across America. The dogs in these homes often bring a sense of safety, love, and companionship with their human owners. Many humans use dogs as stress relievers, but do dogs use humans in the same way? Fifteen dogs were subjected to a 30-minute study where a continuous auditory stressor was played to induce stress. During this time the dog was left alone, with the owner, and with a stranger in a small room at different 5 minute intervals. An initial heart rate was recorded and at the end of each of the 5 minute intervals heart rates were also recorded. Stress behaviors were observed during the entire 30 mins, split into positive and negative behaviors, and scaled from 0-2 on occurrence. Paired T-test compared Owner vs. Stranger heart rates; $p<0.004$ concluded there was a significant difference owner and the stranger. Mean of scaled behaviors were compared between alone, owner, and stranger which found that dogs exhibited more stress behaviors when alone and with a stranger, and more positive behaviors when alone or with owner. The results suggest that during stressful events, the presence of the dog's owner can reduce stress behaviors, promote positive behaviors, and lower heart rates as compared to when the dog is alone or with a stranger.

The Effects of Music Genre and Use of Headphones on Cortisol Levels

Kaycie L. Overmyer

School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

ABSTRACT: Many people listen to music as a form of entertainment or relaxation. Music has an effect on mood and instrumental music can be used to decrease cortisol levels. The objective of this study was to determine if a preferred genre of music or classical music would have more effect on cortisol levels and if the use of headphones would further the impact. I hypothesized that listening to a preferred genre of music with headphones would be the most effective at lowering cortisol levels. This study consisted of 4 groups of 3 students, each with a different variation of music therapy. Each subject provided a saliva sample and a perceived stress level before and after listening to 30 minutes of music. A salivary cortisol ELISA kit was used to determine the cortisol levels for each sample. Paired T-tests were used to determine the effectiveness of each treatment. The group that listened to their preferred genre of music without headphones showed a decrease in cortisol concentrations. The two groups that listened to their preferred genre of music had the highest average decrease in cortisol levels. Preferred genre resulted in less variance between subjects' cortisol concentrations.

Cartridge Collection at Non-Designated Shooting Site: Quantification of Data and Cleanup Analysis

Sean Peckens

School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

Abstract: Target shooting and sighting in weapons is a common practice of sportsman. This activity takes place at designated or non-designated shooting sites. The objective of this project was to clean up three non-designated shooting sites, determine cost of cleanup, and quantify the number of brass casings and shotgun shells at each site. Cleanups were performed by Lake Superior State University at Gaines Highway, Sullivan Lake and Cemetery sites. The data we collected was the number of each type of casing (shotgun, brass). Cleanup costs were calculated based on the average volunteer payment per hour. Effort was calculated based on the number of volunteers and the time of each cleanup. The Gaines Highway site was the most poorly managed with the most shotgun and brass casings, highest effort and highest volunteer of all three sites; followed by the Cemetery Site and finally the Sullivan Lake Site. Heavy metal accumulation can be linked to poorly managed shooting sites (M. Migliorini, et al.,2004). If further studies were conducted, one may see higher heavy metal levels in the soils at the Gaines Highway site. Future cleanup costs and effort may be increased due to poor management. Proactive site management and active individual cleanup could prove beneficial to the environmental health of non-designated shooting sites.

Effect of *Melaleuca alternifolia* (tea tree oil) on *Streptococcus bovis* and *Streptococcus gordonii*

Emily Richardson
School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

ABSTRACT. Tea tree (*Melaleuca alternifolia*) oil is a naturally derived substance that has been used for centuries due to its antimicrobial properties. We hypothesized that oxidative stress was the underlying mechanism that allowed this essential oil to inhibit bacteria. To carry out this study *Streptococcus gordonii* and *Streptococcus bovis* (two bacteria that have different oxygen tolerances), were exposed to a range of tea tree oil concentrations and the effects on bacterial growth were measured. In addition to this, the bacteria were also exposed to an antioxidant (N-acetyl cysteine) in order to observe whether it protected the bacteria from the effects of the essential oil. A luminol test was conducted to determine how much hydrogen peroxide was being emitted with and without the tea tree oil and antioxidant. The result of this study showed that while tea tree oil was effective in high concentrations at killing both types of bacteria, we could not infer that this was due to oxidative stress. Expanding this research in the future could be used to find alternatives to antibiotics in order to fight bacterial infections or determining what mechanisms are involved in the antimicrobial properties of tea tree oil.

A Simulation of Hepatitis B Virus Using NetLogo

Jessica Swailes
School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, MI

ABSTRACT. Hepatitis B is a liver disease that is caused by the Hepatitis B Virus. Hepatitis B is most commonly spread through sexual contact. Human behaviors such as condom-use, getting tested, and the likelihood to have sexual intercourse can influence transmission of Hepatitis B. Agent-based modeling (ABM) is a program that can be used to identify methods behind complex systems, such as the spread and prevention of diseases. In this case, ABM was used demonstrate the impact of human behaviors on the outcome of Hepatitis B. The objectives of this study were to determine how condom use and getting tested influence the spread of Hepatitis B and to demonstrate the utility of modeling to explain the dynamics of an infectious disease. This was done using an ABM program called NetLogo. NetLogo was used to mimic two common behavioral factors of Hepatitis B, condom use and getting tested, demonstrating a real-life scenario of the population. The various simulations showed that using condoms and getting tested drastically decreased the percentage of the population infected by Hepatitis B. This study demonstrates that researchers and physicians can use this type of agent based modeling program to analyze implications of more complicated, less known diseases.

Does *Unionid* Morphology influence *Dreissena polymorpha* fouling on Native Mussels?

Jac Talcott
School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

ABSTRACT. In North America, 202 of the nearly 300 unionid species listed by the Natural Heritage Network are presumed extinct, critically imperiled, or vulnerable due to habitat fragmentation, introduction of exotic species, and pollution. Part of this impact in Michigan waters is a result of recent invasions of zebra mussels (*Dreissena polymorpha*), an invasive mussel that can foul native mussels, resulting in mortality and population declines. Despite tremendous research to understand the impacts of zebra mussels on native mussels, it is still unclear what mussel characteristics (e.g., shell size) and environmental (e.g., substrate) factors affect the extent of unionid colonization by zebra mussels. The objective of this study was to determine if zebra mussel fouling of unionids differed based on the morphology or condition (i.e., living vs dead) on the native mussels. Four site surveys were conducted in Round Lake, Michigan, where data on unionid mussels were collected in transects along the shoreline. Morphology (shell length, width....) and mortality were recorded for all individuals collected, and zebra mussels attached were counted. Three species of native mussels, Eastern Pond Mussel (*Ligumia nasuta*), Fat Mucket (*Lampsilis siliquoidea*), and Giant Floater (*Anodonta grandis*), were collected and the number of attached zebra mussels ranged from 0-61 per individual native mussel. Mortality differed among species, from 100% for Eastern Pond Mussel to 60.7% for Giant Floater. Relationships between zebra mussel fouling and native mussel morphology will be discussed further, along with implications of these findings for conservation of native mussels.

Assessment of *Staphylococcus aureus* on sphygmomanometers

Kelsey M. Waisanen
School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

Abstract: Despite proper cleaning protocols hospital acquired infections are a fairly common occurrence world wide, and can hinder the recovery of many patients. Most hospital staff will perform adequate hand hygiene, however medical equipment could also pose a threat if not cleaned properly. *Staphylococcus aureus*, found living on the skin of a portion of the population, is responsible for most infections due to hospital stays. If it were to be found on medial equipment this could be a possible mode of infection. The cuff and finger probe of three sphygmomanometers were swabbed each week for seven weeks. The swabs were incoculated on to mannitol salt agar, which is a selective and differential for *Staphylococcus aureus*. *Staphycloccos aureus* grew from six of the twenty-seven samples taken over the course of the study. Further research must be done in order to determine why there is a presence of *S. aureus* on the sphygmomanometers.

Stand composition of White pines (Pinus strobus) and Big-Tooth Aspens (Populus grandidentata) in a Mid-Successional Forest in the Eastern Upper Peninsula

Logan Wickert
School of Biological Sciences
Lake Superior State University
Sault Ste. Marie, Michigan

ABSTRACT: Eastern white pine (*Pinus strobus)* and big-tooth aspen (*Populous grandidentata)* are large, fast growing trees common throughout the Great Lakes region. Eastern white pine experienced a near extinction due to the logging boom of the early 1900s. Though some locations didn't regenerate any white pine, in most areas white pine populations recovered. Algonquin Cross Country Ski Area in Sault Sainte Marie, Michigan is a good example of white pine regeneration after the disturbance of the logging boom. At that site, white pines are growing up under large big-tooth aspens. To quantify stand composition and size distribution of one such stand, 20, 5x5 meter quadrats were randomly located and DBH (diameter at breast height) and tree density were recorded by species for all trees greater than 2.5 cm DBH. Trees that too small for measuring DBH were counted and recorded by height. Downed or dead trees were also recorded. A consistent trend was observed that in over half of the quadrat that had a larger Big-tooth aspen, there is undergrowth of 1-3 small white pines. In quadrats containing a large white pine, there were less trees in the entire quadrat. Quadrats that don't contain a dominant White Pine or big-tooth Aspen had an abundance of smaller trees of both species. These results illustrate succession from shade intolerant to partly shade tolerant species after disturbance.

PART 2: Degree-Level Review

Degree Program: B. S. Chemistry

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

1. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

2. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

The American Chemical Society accreditation is the highest standard accreditation for chemistry programs in the world. Our accreditation requires that students have training in all areas of chemistry. We annually assess the state of the courses in our program and our program as a whole. Based on our assessment, we made the following changes to meet current standards:

1. *Our Organic Chemistry II course was changed from a 200 level to a 300 level course to increase the level of student learning outcomes in the course.*
2. *The degree was updated to include CHEM 310 (Applied Spectroscopy) for all chemistry majors.*
3. *We sought funding to increase our spectroscopic capabilities for teaching and student and faculty research, resulting in the acquisition of new MP-AES, IR, IC, qPCR, thermocycler, and NMR instruments.*
4. *We are currently in discussions to alter our seminar courses to better prepare students for their research experiences, their professional presentations, and their careers.*

Quality, Resources and Support (CC 3.A)

3. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

The chemistry B.S. program is ACS approved and meets program level and course level outcomes that are appropriate for this professional training. The guidelines may be found at the following:

https://www.acs.org/content/dam/acsorg/about/governance/committees/training/2015-acs-guidelines-for-bachelors-degree-programs.pdf

The degree audit and the most recent ACS accreditation self-study are attached to this report.

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

4. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

All students complete a capstone senior project, which includes faculty guided research beginning in their junior year or earlier, culminating in professionally presented research products (poster session, formal oral presentation, formal report) their senior year. Many research projects are externally grant funded, providing students opportunities to present at national conferences and gain authorship on peer reviewed publications.

A list of student research abstracts and faculty-student research manuscripts are attached to this report.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@Issu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	
Document Title (if attached) or Filename (if emailed):	
This documentation is relevant to Question number:	
Briefly summarize the content of the file and its value as evidence supporting program review:	

Assessment: Program Four Column

Chemistry - 22oct2018 Assessment_ Program Four Column

Program (CoSE) - Chemistry BS

Mission Statement: The mission of the BS Chemistry degree program is to prepare effective, knowledgeable and professional leaders in the field of chemistry.
Assessment Contact: Dr. R. Adam Mosey

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Knowledge & Skills - The B.S. Chemistry student will demonstrate proficiency in their disciplines **Goal Status:** Active **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations., ILO2 - Use of Evidence - Students will identify the need for, gather, and accurately process the appropriate type, quality, and quantity of evidence to answer a complex question or solve a complex problem., ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art. , ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a	Students will successfully complete CHEM326, CHEM361, CHEM362, CHEM461, CHEM495, and CHEM499 **Criteria Target:** 100% of students will successfully pass CHEM326, CHEM361, CHEM362, CHEM461, CHEM495, and CHEM499 **High Impact Program Practices 1:** Capstone Course(s), Projects **High Impact Program Practices 2:** Undergraduate Research	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of graduates successfully passed CHEM326, CHEM361, CHEM362, CHEM461, CHEM495, and CHEM499 (08/23/2018)	**Use of Result:** Goal Met - Reassess Anually (08/23/2018)
	Students will demonstrate competence in the use of chemical instrumentation and laboratory skills, including safe chemical practices **Criteria Target:** 100 % of students will complete 400 laboratory hours and successfully pass CHEM332 **High Impact Program Practices 1:** Collaborative Assignments, Projects	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100 % of students successfully passed the CHEM332 course. (08/20/2018)	**Use of Result:** Goal met. Re-assess annually. (08/22/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students successfully passed CHEM332. (05/01/2017)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
	Students will demonstrate communication and information retrieval skills **Criteria Target:** 100% of students will successfully pass CHEM495 and	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students successfully completed both CHEM495 and CHEM 499 (08/23/2018)	**Use of Result:** Goal Met - Reassess Annually (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
problem, or achieving a goal.	CHEM499 **High Impact Program Practices 1:** Capstone Course(s), Projects **High Impact Program Practices 2:** Writing-Intensive Course(s)	**Related Documents:** Chem & Envi Science Senior Thesis Presentations .pdf	
Employability and Readiness for Graduate and Professional Study - The B.S. Chemistry Graduate will demonstrate readiness for employment as a chemist, science technician, or chemical technician at the baccalaureate level or graduate and professional level study. **Goal Status:** Active **Institutional Learning:** ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal.	**Indirect - Survey, including self-evaluation, peers, or graduates -** Graduate/Alumni Survey **Criteria Target:** Greater than 50% of students will express satisfaction with with their preparedness for professional employment or graduate/professional study. **High Impact Program Practices 1:** Not applicable to this outcome **High Impact Program Practices 2:** Not applicable to this outcome	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Greater than 50% of graduates self reported as satisfied with their preparation. (08/23/2018) **Related Documents:** LSSU Graduate Survey Chemistry.xlsx	**Use of Result:** Goal met - reassess annually. (08/23/2018)
	Graduates will gain entry into graduate and professional programs. **Criteria Target:** Graduates will gain entry into graduate and professional programs.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 1 graduate was accepted to a graduate program. (08/23/2018)	**Use of Result:** Goal met - reassess annually. (08/23/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 2 students were admitted into graduate/professional programs. (06/10/2017)	**Use of Result:** Goal met - reassess annually. (08/23/2018)
Scholarship - The B.S. Chemistry student will engage in University-supported faculty-led research in chemistry. **Goal Status:** Active	**Other Findings**	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Students presented results from their senior research projects at the LSSU Annual Student Research Symposium and Chemistry and Environmental Senior Research Presentations and at a national American Chemical Society meeting. (04/30/2018)	**Use of Result:** Goal met - reassess annually. (08/23/2018)
	Direct - Laboratory, Clinical, Skill/Competency Assessments - The BS Chemistry student will engage in university-supported faculty led research in chemistry.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students presented results from their senior research projects at the Symposium and Senior Research Presentations. (08/23/2018)	**Use of Result:** Goal met - reassess annually. (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Criteria Target: 100% of students will complete a senior research project.	**Related Documents:** Chem & Envi Science Senior Thesis Presentations .pdf	

LAKE SUPERIOR STATE UNIVERSITY

57	19	68	16
La	K	Er	S
138.91	39.10	167.26	32.07

B.S. Chemistry (Effective 2016)

Name_____ **ID#**_____ **Advisor**_____
Expected Date of Graduation_____ **Chair Approval** _____

Chemistry Degree Requirements (57 credits min.)		Sem./Grade
CHEM 115 General Chemistry I	5	____/____
CHEM 116 General Chemistry II	5	____/____
CHEM 225 Organic Chemistry I	4	____/____
CHEM 231 Quantitative Analysis	4	____/____
CHEM 261 Inorganic Chemistry	4	____/____
CHEM 326 Organic Chemistry II	4	____/____
CHEM 310 Applied Spectroscopy	4	____/____
CHEM 332 Instrumental Analysis	4	____/____
CHEM 351 Introductory Biochemistry	4	____/____
CHEM 361 Physical Chemistry I	4	____/____
CHEM 362 Physical Chemistry II	3	____/____
CHEM 363 Physical Chemistry Lab	1	____/____
CHEM 395 Junior Seminar	1	____/____
CHEM 461 Adv. Inorganic Chemistry	3	____/____
CHEM 462 Adv. Inorganic Chem. Lab	1	____/____
CHEM 495 Senior Project	2	____/____
CHEM 499 Senior Seminar	1	____/____
CHEM Electives (300 level or higher)	3 cr. min.	____/____

Degree Audit Sheet Directions: Fill in the semester and grade for each course as completed. Two semesters before your intended graduation date this form should be filled in indicating the courses you are then taking, and those you will take in the next semester. Have the form signed and submit to the Fletcher Center with your Declaration of Candidacy form. You must have a signed Course Substitution/Waiver Form for any deviations from the audit below – see your advisor for this form.

Other Departments (19-20 credits)			
Math Option:			
MATH 151 Calculus I	4	____/____	
MATH 152 Calculus II	4	____/____	
or			
MATH 112 Calc. for Bus. Life Sci. I	4	____/____	and
EGNR 140 Lin. Alg. Num. Meth.	2	____/____	and
EGNR 245 Calc. App. For Tech.	3	____/____	
BUSN 211 Business Statistics	3	____/____	
or			
MATH 207 P. of Stat. Meth.	3	____/____	
Two Semesters of Physics (8 cr. min.)	4	____/____	
	4	____/____	

ACS Chemistry for Life™
AMERICAN CHEMICAL SOCIETY

General Education (25 credits minimum)					
ENGL 110 First-Year Comp	3	____/____	ENGL 111 First-Year Comp II	3	____/____
Approved Social Science*	3	____/____	Approved Social Science*	3	____/____
HUMN 251 Humanities I	4	____/____	Approved Humanities*	3	____/____
COMM 101 Speech	3	____/____	Approved Social Diversity*	3	____/____

*Consult list for approved courses

General Electives credits must be completed for a minimum of 124 total credits (19-20 credits)

_____ _____ _____ _____ _____

--------Office Use Only----------

___ At MINIMUM of 124 total credits
___ 2.5 GPA Overall ___ 2.5 GPA in major

_____
Dean Date

Effective Date: Fall 2016

Typical B.S. Chemistry Sequence (124 Credits minimum)

Fall Freshman CHEM 115 General Chemistry I (5) MATH 112 Calc. for Bus. And Life Sci. I (4) (or MATH 151 Calculus I (4)) COMM 101 Fundamentals of Speech Comm. (3) ENGL 110 First-Year Composition I (3) Total: 15	Spring Freshman CHEM 116 General Chemistry II (5) EGNR 140 Linear Alg. Num. Methods (2) (or MATH 152 Calculus II (4)) ENGL 111 First-Year Composition II (3) HUMN 251 Humanities I (4) Approved Social Diversity** (3) Total: 17-19
Fall Sophomore CHEM 225 Organic Chemistry I (4) CHEM 231 Quantitative Analysis (4) (Fall) EGNR 245 Calc. App. For Technology (3) (Not necessary If MATH 151 + MATH 152) PHYS 231 Applied Physics I (4) (Fall) (or PHYS 221 Principles Of Physics I (4)) Total: 12-15	Spring Sophomore CHEM 326 Organic Chemistry II (4) (Spring) CHEM 261 Inorganic Chemistry (4) (Spring) PHYS 232 Applied Physics II (4) (Spring) (or PHYS 222 Principles of Physics II (4)) BUSN 211 Business Statistics (3) (or MATH 207 Principles Of Statistics (3)) Total: 15
Fall Junior CHEM 351 Biochemistry I (4) (Fall) CHEM 361 Physical Chemistry I (4) (Fall) CHEM 363 Physical Chemistry Lab (1) General Elective (4) General Elective (4) Total: 17	Spring Junior CHEM 332 Instrumental Analysis (4) (Spring) CHEM 395 Junior Seminar (1) (Spring) CHEM 310 Applied Spectroscopy (3) (Spring) CHEM 3XX or Higher Elective (3 or 4) General Elective (3) General Elective (3) Total: 17-18
Fall Senior CHEM 362 Physical Chemistry II (3) (Fall) CHEM 495 Senior Project (2) General Elective (4) General Elective (4) Approved Social Science** (3) Total: 16	Spring Senior CHEM 461 Adv. Inorganic Chemistry (3) (Spring) CHEM 462 Adv. Inorganic Chemistry Lab (1) (Spring) CHEM 499 Senior Seminar (1) General Elective (4) Approved Humanities** (3) Approved Social Science** (3) Total: 15

**Consult official University list of approved General Education Courses
(Fall) = Course typically only offered Fall semester, some may be alternate years.
(Spring) = Course typically only offered Spring semester, some may be alternate years.

2015 Periodic Report
to the
ACS Committee on Professional Training

Please consult the ACS Guidelines (http://www.acs.org/cpt) before completing this report. The information contained in this report should pertain only to your undergraduate program. To facilitate committee review, all responses must be provided on this form. Extra pages for the tables are available under the Templates tab on CPRS.

Name of Institution: Lake Superior State University

City, State, and Zip Code: 650 W. Easterday Ave., Sault Sainte Marie MI 49783

Report Prepared by (e.g., Dr. Mary Smith or Juan Ruiz): Dr. Derek D. Wright
E-mail Address: dwright1@lssu.edu
Phone Number: (906) 635-2628

Current Chemistry Department Chair
Name: Dr. Derek D. Wright
Title: Associate Professor

Name of Department: School of Physical Sciences

Section 1

1.1 Degrees Offered in Chemistry (check those offered)

- Bachelor's: ☒
- Master's: ☐
- Ph.D.: ☐

1.2 Number of Calendar Weeks per Term (not counting final exams)

- Semester: 14
- Quarter:
- 4-1-4:
- Other:

1.3 Provide the number of students in the current (most recently completed) academic year:

Entire Campus	2432
Undergraduates	2432
Chemistry Seniors	15
Sum of enrollments in all undergraduate chemistry courses	747

1.4 Provide the number of bachelor's-degree graduates during the past six years who went on to:

Graduate School in the Chemical Sciences	18
Medical and other Professional Schools	5
Industry	14
Teaching	0
Other/Unknown	14

Section 2: Institutional Environment

2.1 Is the institution accredited by a regional accrediting association? Yes ☒ No ☐
Name of Accrediting Association Higher Learning Commission

2.2 Is the chemistry department organized as an independent administrative unit? Yes ☐ No ☒

a. If no, how is the department or program administered and to whom does the department administrator report?

Chemistry is housed within the School of Physical Sciences, which also includes programs in the Environmnetal Sciences, and Geology. The School has a Chair, who reports to the Dean of Natural and Mathmatical Sciences.

b. If no, who controls budgetary, personnel, and teaching decisions for the chemistry program, and how are chemistry faculty involved?

Budgetary, some personnel, and course scheduling decisions are made primarily by the Chair of Physical Sciences, through close consultation with the faculty. These decisions are approved by the Dean.

2.3 Check the Minimum Salary for each Rank of Chemistry Faculty (Nine Months)

Minimum Salary	Professor	Associate Professor	Assistant Professor	Long-term, permanent
Below $51K	☐	☒	☒	☐
$51 - $60K	☒	☐	☐	☐
$61 - $70K	☐	☐	☐	☐
$71 - $80K	☐	☐	☐	☐
$81 - $90K	☐	☐	☐	☐
Over $90K	☐	☐	☐	☐

2.4 Chemistry Expenditures (rough estimates – 2 significant figures):

If your expenditures are over $60,000 per year, excluding internal and external grants, salaries, and library budget, check here ☒ and go to Item 2.5.

	Current	Annual Average Over the Past Five Years
Operating Expenditures Exclusive of Salaries		
Instrument Maintenance and Repair		
Student and Faculty Travel		
Grants		

2.5 Describe whether the level of institutional support allows the department to meet its teaching, infrastructure, and faculty development needs.

The Institution supports 8 faculty & 2 full time staff for lab prep and instrumentation maintenance. Our physical facilities are located in Crawford hall, which was renovated in the year 200. We have 5 instructional labs, one shared instrumentation room, 3 shared research labs dedicated primarily to chemistry instruction and research, and a central stockroom. In addition to the base budget and course fees which generate ~$85,000 annually, the Dean has a discretionary fund for instrument maintenace and replacement, which typically invests ~$40,000 annually in Chemistry equipment. Additional investments typically ~$30,000 annually are made using revenue generated by the Environmental Analysis Lab, a contract lab operated by the School.

Section 3: Faculty and Staff

3.1 Number of Chemistry Faculty in the Spring 2015 Academic Term **(If you have no faculty in a particular category, record a "0").** Please be sure the totals in the top row (Full-time/Part-time totals) add up below.

Faculty	Total Faculty	With Ph.D.	Male	Female	African American	Native American	Asian American	Hispa Ameri
Permanent total	8	8	6	2	0	0	0	0
Full-time	8	8	6	2	0	0	0	0
Tenured	4	4	3	1	0	0	0	0
Pre-tenured	4	4	3	1	0	0	0	0
Long-term, non-tenure track	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0
Tenured	0	0	0	0	0	0	0	0
Pre-tenured	0	0	0	0	0	0	0	0
Long-term, non-tenure track	0	0	0	0	0	0	0	0
Temporary total	0	0	0	0	0	0	0	0
Full-time	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0

3.2 Number of Instructional Staff (Do not include faculty listed in Item 3.1 or Teaching Assistants. **If you have no instructional staff in a particular category, record a "0".**)

Instructional Staff	Total Staff	With Ph.D.	Male	Female	African American	Native American	Asian American	Hispa Ameri
Long-term*	3	2	2	1	0	0	1	0
Full-time	0	0	0	0	0	0	0	0
Part-time	3	2	2	1	0	0	1	0
Temporary	0	0	0	0	0	0	0	0
Full-time	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0

* Employed for three years or more or expectation of employment for at least three years

3.3 The ACS is concerned about potential overreliance on temporary (part-time and full-time) faculty and instructional staff. If the total number of temporary (full- or part-time) faculty and instructional staff exceeds 50% of the number of permanent faculty and long-term instructional staff listed in items above (3.1 and 3.2) explain their roles in student instruction.

3.4 a. Briefly describe your activities (especially successes) in expanding faculty diversity over the last five years.

Consistant with state and federal laws, LSSU is an equal opportunity employer. All job postings include language encouraging diverse applicants, and positions are posted in the Chronicle of Higher Education, Higher Ed Jobs, and the LSSU Website. One female faculty member in Chemistry was hired in the last 5 years. Two other female faculty, one hispanic, were recently hired in Physics and Env. Sci

b. Describe any attributes of diversity among your faculty not captured in Items 3.1 and 3.2.

None

3.5 a. Number of Support Staff:

Secretarial	0.5
Stockroom	2
Instrument Technicians	
Other	

b. Comment on the adequacy of support staff:

Our suppoert staff consists of one Secretary (shared with Biology) and two full time staff members, a laboratory manager and a technician. The labopratory manager is responsible for managing the stockroom, ordering supplies, and ensureing that instrumentation is in working order. The Technician assists the laboratory manager in the stockroom and with instument maintenance and repair. We also employ 10-15 students 6-8 hrs per week each semster to assist with lab prep. This staffing arrangement has proven to be adequate to support our program.

3.6 Describe the professional development opportunities (including sabbaticals) that are available to chemistry faculty and instructional staff.

The Univeristy provides $1000 annually to faculty which can be used for professional development activities at their discretion. Each acadmic year, 3 semesters of paid sabattical are available to the Full time Faculty (~120 faculty). Two of the current Chemistry faculty have received a full year sabattical in the past 7 years. Additional professional development opportunities include support for seminar speakers and conference attendance through units such as the Faculty Center for Teaching, and the LSSU Foundation.

3.7 Report the number of chemistry faculty and instructional staff who have taken a sabbatical or professional leave in the last six years.

Requested 1

Granted 1

3.8 Teaching Contact Hours for 2014-2015 Academic Year (Classroom and Lab)
Please provide the minimum and maximum numbers that occurred during this academic year. **The ranges reported here should match the numbers reported in Table 3.1.**

a. Contact Hours/week for Chemistry Faculty (exclusive of research):
Range from 10 to 16 ; Average 14.3

b. Contact Hours/week for Instructional Staff:
Range from 2 to 6 ; Average 4

c. If you need to explain how contact hours are counted or if there is a special situation, for example, for online instruction please explain:

d. Are maximum and/or minimum teaching loads established as an institutional policy?
Yes ☒ No ☐

If yes, explain briefly:

Teaching loads are established under the Faculty Association agreement with a minimum of 12 contract hours per semester. One contract hour is equal to one hour of lecture instruction, while one hour of lab instruction is equal to 0.66 contract hours. Teaching load (release time) is awarded to the School Chair (3 hrs per semster) and coordinaters of multiple lab sections. The maximum load is 32 hrs/year

3.9 a. Do you use undergraduate student teaching assistants? Yes ☐ No ☒

If yes, answer items b. and c.

b. Describe the formal instruction and assistance in laboratory and/or classroom teaching provided to undergraduate student teaching assistants.

Table 3.1 – Teaching Contact Hours

Provide the **actual contact hours** per week for each individual involved in undergraduate instruction for the 2014-2015 academic year. List one faculty member per row and enter as many faculty per page as possible. List non-tenure-track faculty, temporary faculty, and instructional staff and **identify them with the key below**. Do not include graduate teaching assistants. If the average number of contact hours for your department is less than 12 contact hours per week, complete Table 3.1 for those individuals with 12 or greater contact hours per week. Additional copies of this table are available under the Template tab on CPRS.

	Fall Semester/1st Quarter 2014				Spring Semester/2nd Quarter 2015		
Faculty Member (list according to rank)	**Course Number and Title**	**1***	**2***	**3***	**Course Number and Title**	**1***	**2***
Curie, Marie (Professor)	CHEM112 – Gen Chem I CHEM 257 – O. Chem I CHEM 358 – O.Chem Lab (2 sections)	3 3 0	0 3 4	13	CHEM257 – Analytical Chemistry CHEM360 – O. Chem II	3 3	3 3
Iretski, Alexei (Professor)	CHEM115 - Gen Chem CHEM362 - P Chem 2 CHEM363 - P Chem Lab	4 3 0	4 0 3	14	CHEM115 - Gen Chem CHEM116 - Intro P Chem CHEM261 - Inorganic Chem CHEM461/462 - Adv Inorg Che	4 0 3 3	0 3 0 3
Werner, R. Marshall (Professor)	CHEM109 - App Chem Lab CHEM110 - App Org & Biochem CHEM351 - Biochem 1	0 3 3	3 0 6	15	CHEM110 - App Org & Biochem CHEM 115 - Gen Chem CXHEM452 - Adv Biochem	3 0 2	4 2 4
Wright, Derek (Associate Professor)	NSCI103 - Env Sci NSCI104 - Env Sci Lab EVRN317 - Env Health App	3 0 3	0 2 3	11	NSCI103 - Env Sci NSCI104 - Env Sci Lab NSCI116 - Oceanography	3 0 3	0 2 2
Heth, Christopher (Assistant Professor)	CHEM116 - Intro P Chem lab CHEM231 - Quant Analysis CHEM499 - Senior Sem HONR101 - Honors Sem 1	0 3 1 3	3 6 0 0	16	CHEM332 - Instrumental Anal CHEM445 - Forensic Sci CHEM499 - Senior Thesis	3 1 1	9 0 0
Johnson, Steven (Assistant Professor)	NSCI110 - Intro to Forensics CHEM115 - Gen Chem CHEM116 - Intro P Chem	3 4 4	2 2 0	15	CHEM116 - Intro P Chem CHEM445 - Forensic Sci	4 2	6 3
Kelly, Megan (Assistant Professor)	CHEM108 - Applied Chem EVRN425 - Env Sysytems NSCI104 - Env Sci lab USEM101 - Univ. Seminar 1	3 3 0 1	3 3 2 0	15	CHEM108 - Applied Chem CHEM115 - Gen Chem CHEM116 - Intro P Chem NSCI104 - Env Sci lab	3 0 0 0	3 2 3 4
Mosey, R. Adam (Assistant Professor)	CHEM110 - App Org & Biochem CHEM225 - Organic Chem 1 HONR302 - Honors Seminar	0 3 3	2 6 0	14	CHEM116 - Intro P chem CHEM226 - Organic Chem 2	0 3	3 9
Blanchard, Roger @ (Adjunct Instructor)	CHEM110 - App Org & Biochem CHEM115 - General Chem	0 0	2 2	4			
Nguyen-Mosey, Thu @ (Adjunct Instructor)	CHEM115 - General Chem CHEM225 - Organic Chem 1	0 0	2 3	5	CHEM225 - Organic Chem 1	3	3
Southwell, Benjamin (Adjunct Instructor)	CHEM115 - General Chem	0	2	2	CHEM261 - Inorganic Chem	0	3

*1 Number of class hours scheduled per week.

*2 Number of contact hours of lab per week.

*3 Total of columns 1 and 2 for a grand total for each individual.

\# Non-tenure faculty

@ Temporary faculty and instructional staff

\+ Long-term instructional staff

Section 4: Infrastructure

4.1 Comment on the adequacy and condition of your department's instruments and lab apparatus to meet your program's teaching and research needs. Describe the arrangements for repair and maintenance of instruments.

Instrumentation maintenance and repair is primarily conducted and coordinated by the science lab manager and the technician, with occasional assistance from faculty. Manufacturer service contracts are also utilized in some instances.

4.2 Do you rely on off-site instrumentation to meet your department's research needs? Yes ☐ No ☒

If yes, please describe the arrangement:

4.3 Comment on the adequacy of the facilities and space available for the undergraduate chemistry program.

We operate 5 instructional labs, 3 shared research labs, and a core instrumentation lab all dedicated to the undergraduate chemistry curriculum. We also share a computer lab which provides access to computational chemistry software (Spartan & Spartan Student). These facilites are properly supplied with safety equpiment including exhaust hoods, gas/vacuum etc., and are adequate to support our program.

4.4 a. Indicate the number of chemistry journals to which students have immediate institutional access on your campus. **If students have access to 30 or fewer chemistry journals, complete Table 4.2.**

30 or fewer ☐ More than 30 ☒

b. Do your students and faculty have access to journals that are not available on campus through interlibrary loan? Yes ☒ No ☐

c. What types of access do undergraduate students and faculty have to chemical information databases on your campus? (Check all that apply.)

Online through ChemSpider	☒
Online through SciFinder	☒
Online through STN	☐
Online through Web of Science	☐
Other access	☐

Specify _____

4.5 What is the maximum number of students in a laboratory section who are directly supervised per faculty member, instructional staff member, or teaching assistant? 24

Table 4.2 – Journal List

Indicate the current chemistry-related periodicals to which students have print or online access. Please use the blanks provided if you have additional journals to list.

General Content

- ☐ Accounts of Chemical Research
- ☐ ACS Central Science
- ☐ Angewandte Chemie Intl Edition in English
- ☐ Chemical Communications
- ☐ Chemical Science
- ☐ Chemistry – A European Journal
- ☐ Chemistry Letters
- ☐ Journal of the American Chemical Society
- ☐ Nature, Nature Chemistry
- ☐ New Journal of Chemistry
- ☐ Proceedings of the National Academy of Science
- ☐ Science

Topical titles

- ☐ ACS Chemical Biology
- ☐ ACS Chemical Neuroscience
- ☐ ACS Medicinal Chemistry Letters
- ☐ ACS Nano
- ☐ Advanced Functional Materials
- ☐ Advances in Heterocyclic Chemistry
- ☐ Advanced Materials
- ☐ Advanced Synthesis and Catalysis
- ☐ Advances in Protein Chemistry
- ☐ Analyst
- ☐ Analytica Chimica Acta
- ☐ Analytical and Bioanalytical Chemistry
- ☐ Analytical Biochemistry
- ☐ Analytical Chemistry
- ☐ Applied Catalysis A
- ☐ Applied Spectroscopy
- ☐ Beilstein Journal of Organic Chemistry
- ☐ Biochemical Journal
- ☐ Biochemistry
- ☐ Biochimica et Biophysica Acta
- ☐ Bioconjugate Chemistry
- ☐ Biomacromolecules
- ☐ Biomaterials
- ☐ Bioorganic Chemistry
- ☐ Bioorganic and Medicinal Chemistry Letters
- ☐ Chemical Education: Research and Practice
- ☐ Chemical Educator
- ☐ Chemistry of Materials
- ☐ ChemPhysChem
- ☐ Chemical Physics Letters
- ☐ Chirality
- ☐ Combinatorial Chemistry and High Throughput Screening
- ☐ Current Opinion in Chemical Biology
- ☐ Dalton Transactions
- ☐ Electrophoresis
- ☐ Environmental Science and Technology
- ☐ European Journal of Inorganic Chemistry
- ☐ European Journal of Organic Chemistry
- ☐ FEBS Journal
- ☐ Green Chemistry
- ☐ Heterocycles
- ☐ Inorganic Chemistry
- ☐ Journal of the American Society for Mass Spectrometry
- ☐ Journal of Applied Polymer Science
- ☐ Journal of Bacteriology
- ☐ Journal of Biological Chemistry
- ☐ Journal of Biological Inorganic Chemistry
- ☐ Journal of Catalysis
- ☐ Journal of Chemical Ecology
- ☐ Journal of Chemical Education
- ☐ Journal of Chemical Information and Modeling
- ☐ Journal of Chemical Physics
- ☐ Journal of Chemical Theory and Computation
- ☐ Journal of Chromatography A, B
- ☐ Journal of Medicinal Chemistry
- ☐ Journal of Molecular Biology
- ☐ Journal of Organic Chemistry
- ☐ Journal of Physical Chemistry A, B, C
- ☐ Journal of Physical Chemistry Letters
- ☐ Journal of Polymer Science Part A
- ☐ Journal of Proteome Research
- ☐ Langmuir
- ☐ Macromolecules
- ☐ Molecular Cell
- ☐ Nanoletters
- ☐ Nature Chemical Biology, Structural and Molecular Biology
- ☐ Nucleic Acids Research
- ☐ Organic and Biomolecular Chemistry
- ☐ Organic Letters
- ☐ Organometallics
- ☐ Physical Chemistry Chemical Physics
- ☐ PLOS One
- ☐ Polymer
- ☐ Polymer Degradation and Stability
- ☐ Supramolecular Chemistry
- ☐ Synlett
- ☐ Synthesis
- ☐ Tetrahedron
- ☐ Tetrahedron Letters

4.6 a. Are the following laboratory facilities **adequate** for your instructional program?

Safety showers	Yes ☒	No ☐	Hoods	Yes ☒	No ☐
Eye washers	Yes ☒	No ☐	Ventilation	Yes ☒	No ☐
Fire extinguishers	Yes ☒	No ☐			

b. If no is checked for any item above, please explain.

4.7 a.

	Yes	No
Does the department/university have established safety rules?	☒	☐
Does the department/university have emergency reporting procedures?	☒	☐
Does your department have a written chemical hygiene plan?	☒	☐
Are there adequate facilities and arrangements for disposal of chemical waste?	☒	☐
Are safety information and reference materials (e.g., MSDS, SDS, SOPs) readily available to all students and faculty?	☒	☐
Is appropriate personal protective equipment available and used by all students and faculty?	☒	☐

b. If no is checked for any of the above, please explain.

c. Does the chemistry department or program have a safety committee or safety officer? Yes ☒ No ☐

If a safety committee exists, how often does it meet? 2 times per semester, or more frequently as needed

Section 5: Curriculum

5.1 a. Are all foundation courses taught annually? Yes ☒ No ☐

b. If no is checked above, indicate the foundation courses that are **not** taught annually.

c. If all of the courses required for student certification are not taught annually, describe how students can complete the requirements for a certified chemistry degree within four years.

Some of the advanced courses are taught on a regular alternate year schedule that is available in advance to both students and faculty advisers. The scheduled meeting times are cooredinated with other departments to prevent/minimize scheduling conflicts.

d. Are at least four semester-long (or six quarter-long) in-depth courses taught annually, exclusive of research? Yes ☒ No ☐

5.2 Refer to section 5.6 of the ACS Guidelines for the definition of degree tracks and **list only those degree tracks that lead to an ACS-certified bachelor's degree** in chemistry or related field.

Track 1 BS Chemistry (ACS)
Track 2 BS Biochemistry (ACS)
Track 3 BS Forensic Chemisty (ACS)
Track 4
Track 5
Track 6
Track 7

5. 3 Please report the number of hours in each course listed below in Table 5.1 that reflects supervised, hands-on lab experience.
CHEM 115 has a total of 28 supervised laboratory hours

Complete Tables 5.1 – 5.4 only for those courses in degree tracks that may lead to an ACS-certified bachelor's degree.

Table 5.1 – Introductory Course Work

List all introductory chemistry course work students may use to prepare for the foundation course work listed in Table 5.2. Do not include courses listed in Table 5.2 and 5.3 or courses that are not used for ACS certification purposes. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Credit Hours	Tracks[2]						
		Class	Lab			1	2	3	4	5	6	7
CHEM 115	General Chemistry	58	28	Chemistry and Chemical Reactivity, Hybrid Edition by Kotz	5	R	R	R	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–

1. Total Hours refers to the total contact hours per term. Do not record credit hours or contact hours per week in this column.
2. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose for each degree track.

Table 5.2 – Foundation Course Work

List below all course work students may use to satisfy the FOUNDATION requirements in the sequence suggested for ACS certification. Do not include courses listed in Tables 5.1 and 5.3 or courses that are not used for ACS certification purposes. Refer to Section 5.3 of the ACS Guidelines for the definition of a foundation course. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	CH[2]	Subdisciplinary % Breakdown[3]					Tracks[4]						
		Class	Lab			A	B	I	O	P	1	2	3	4	5	6	7
CHEM 116	General Chemistry II-Intro to Physical Chemistry	58	42	Chemistry and Chemical Reactivity, Hybrid Edition by Kotz	5			10		90	R	R	R	–	–	–	–
CHEM 225	Organic Chemistry I	44	42	Organic Chemistry, David Klein, 1st Edition	4				100		R	R	R	–	–	–	–
CHEM 231	Quantitative Analysis	44	42	Quantitative Chemical Analysis by D. C. Harris	4	100					R	R	R	–	–	–	–
CHEM 261	Inorganic Chemistry	44	42	Descriptive Inorganic Chemistry. Rayner-Canham and Overton	4			100			R	R	R	–	–	–	–
CHEM 351	Introductory Biochemistry	44	42	Lippincott's Illustrated Review: Biochemistry (Harvey and Ferrier) 5th	4		100				R	R	R	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. State the approximate percentage of each subdiscipline found in each course (analytical chemistry (A), biochemistry (B), inorganic chemistry (I), organic chemistry (O), and physical chemistry (P)). The percentage coverage must add up to 100% for each course. For example, Biophysics I might be 40% biochemistry and 60% physical or Organic Chemistry I might be 100% organic.
4. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose to meet the foundation requirements for each degree track.

Table 5.2 – Foundation Course Work (continued)

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	CH[2]	Subdisciplinary % Breakdown[3]					Tracks[4]						
		Class	Lab			A	B	I	O	P	1	2	3	4	5	6	7
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. State the approximate percentage of each subdiscipline found in each course (analytical chemistry (A), biochemistry (B), inorganic chemistry (I), organic chemistry (O), and physical chemistry (P)). The percentage coverage must add up to 100% for each course. For example, Biophysics I might be 40% biochemistry and 60% physical or Organic Chemistry I might be 100% organic.
4. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose to meet the foundation requirements for each degree track.

5.4 If any courses are listed as alternative courses in Table 5.2, please explain how students satisfy the foundation requirements for certification for each degree track. List the names and course numbers. If a course is listed here, ensure it is also entered in Table 5.2.

Table 5.3 – In-Depth Course Work

List the in-depth course work used for ACS certification. Do not include courses listed previously in Tables 5.1 and 5.2. Refer to Section 5.4 of the ACS Guidelines for the definition of an in-depth course. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Foundation Prerequisite Course #	CH[2]	Tracks[4]						
		Class	Lab				1	2	3	4	5	6	7
CHEM 226	Organic Chemisty II	44	42	Organic Chemistry, David Klein, 1st Edition	CHEM225	4	R	R	R	–	–	–	–
CHEM 310	Applied Spectroscopy	44	42	Spectrometric Identification of Organic Compounds" (7th ed), R.M. Silverstein, et. al. 2005.	CHEM226 CHEM261	4	E	E	E	–	–	–	–
CHEM 332	Instrumental Analysis	44	42	Undergraduate Instrumental Analysis by J.W. Robinson, E. M. Skelly-Frame, G.M. Frame II, 6th	CHEM 231	4	R	R	R	–	–	–	–
CHEM 341	Environmental Chemistry	44	42	Environmental Chemistry 8th ed S. Manahan	CHEM 231 CHEM 225	4	E	E	E	–	–	–	–
CHEM 353	Introductory Toxicology	44		Casarett & Doull's Toxicology: The Basic Science of Poisons by Klaassen	CHEM 225 CHEM 351	3	E	R	R	–	–	–	–
CHEM 361	Physical Chemistry I	58		Physical Chemistry.Silbey, Alberty, Bawendi, Wiley,4/E 2005	CHEM 116	4	R	E	E	–	–	–	–
CHEM 362	Physical Chemistry II	44		Physical Chemistry. Silbey, Alberty, Bawendy, Wiley,4/E	CHEM 116	3	R	E	E	–	–	–	–
CHEM 363	Physical Chemistry Lab		42	None	CHEM 116	1	R	R	E	–	–	–	–
CHEM 445	Forensic Science	44	42	Forensic Chemistry Handbook by Kobilinsky	CHEM 231 CHEM 332	4	E	E	R	–	–	–	–
CHEM 452	Adv Bochemical and Molecular Tec	28	56	Lippincott's Illustrated Review: Biochemistry (Harvey and Ferrier) 5th Ed	CHEM 351	4	E	R	E	–	–	–	–
CHEM 461	Adv Inorganic Chem	44		Inorganic Chemistry. Miessler, Tarr. 5th Ed, Pearson Education, 2014	CHEM 231 CHEM 225 CHEM 261	3	E	E	E	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

Table 5.3 – In-Depth Course Work (continued)

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Foundation Prerequisite Course #	CH[2]	Tracks[4]						
		Class	Lab				1	2	3	4	5	6	7
CHEM 462	Adv Inorganic Chem Lab		42	None	CHEM 261	1	E	E	E	–	–	–	–
CHEM 495	Senior Project (undergraduate research)		84	None	N/A	2	R	R	R	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
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							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

5.5 How do your ACS-certified graduates **in each degree track** meet the in-depth course requirements? List the names, course numbers, and indicate if required or elective. If a course is listed here, ensure it is also entered in Table 5.3. Where a student may choose among two or more courses, clarify the options, and how many courses are required for certification.

BS Chemistry - Required: CHEM 226 Organic Chemistry II (Organic), CHEM 332 Instrumental Analysis (Analytical), CHEM 361 Physical Chemistry I (Physical), CHEM 362 Physical Chemistry II (Physical), CHEM Electives at the 300 level or higher (11 credits)

BS Biochemistry - Required: CHEM 226 Organic Chemsitry II (Organic), CHEM 332 Instrumental Analysis (Analytical), CHEM 452 Advanced Biochemical Mol Tech (Biochemistry), 4 cr CHEM electives (either CHEM 361 or 362 for certification, Physical)

BS Forensic Chemistry - Required: CHEM 226 Organic Chemistry II (Organic), CHEM 332 Instrumental Ananlysis (Analytical), 3 cr CHEM Electives (must be either CHEM 361 or 362 for certification, Physical)

5.6 How do ACS-certified graduates **in each degree track** meet the laboratory requirement of 400 hours? Include the subdisciplinary area (ABIOP) covered by each course, the course name, the course number, the number of lab hours devoted to each area, and indicate whether courses are required or elective. Please record the total number of labs hours for the courses listed in each track. Do not include lab hours from general or introductory lab courses. If a course is listed here, ensure it is also entered in Table 5.2 or 5.3.

Example: Organic Chemistry II (CH 232), Organic 45 hours

BS Chemistry, Required - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Physical Chemistry Lab (CHEM363), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231); Analytical 42 hrs, Instrumental Analysis (CHEM 332), Analytical 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs; Inorganic Chemistry (CHEM 261); 42 hrs; Senior Project (CHEM 495), 84 hrs. Chemistry Electives also provide additional laboratory hours (minimum 420 hrs.)

BS Biochemistry, Required - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Physical Chemistry Lab (CHEM363), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231); Analytical 42 hrs, Instrumental Analysis (CHEM 332),Analytical 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs; Adv Biochem (CHEM 452), 56 hrs; Inorganic Chemistry (CHEM 261); 42 hrs; Senior Project (CHEM 495) 84 hrs (minumum 476 hrs.)

BS Forensic Chemistry - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231), Analytical 42 hrs; Instrumental Analysis (CHEM 332) Analytical, 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs, Inorganic Chemistry (CHEM 261), 42 hrs; Adv Biochemistry (CHEM 452), Biochemistry 56 hrs OR Applied Spectroscopy Analytical, 42 hrs; Senior Project (CHEM 495) 84 hrs. (minimum 420 hrs)

5.7 Describe the computational chemistry facilities and software (e.g., Gaussian) that students use in their course work and research.

A workstation with Spartan '14, and 10 workstations with Spartan Student are available in the instructional computer lab (CRW 107). One additional student workstation with Spartan Student and Titan is available in the introductory chemistry lab (CRW334).

5.8 How do students gain hands-on experience using chemical instrumentation?

Students gain hands on experience with instrumentation throughout the curriculum in both coursework and research. For instance, students in Orgainic Chemistry I (CHEM 225) use NMR and FTIR throughout the semester to characterize their products. Students in Instrumental Analysis (CHEM 332)gain experience with a range of analytical techniques, including instrumentation in each of the five areas of Optical Molecular Spectroscopy, Optical Atomic Spectroscopy, Mass Spectrometry, Chromatography, and Electrochemistry. In dpeth courses with laboratories provide additional hands on opportunities to use instrumentation. For instance, NMR and FTIR are also heavily used in Organic Chemisty II (CHEM 226), and Applied Spectroscopy (CHEM 310). Applied in depth courses such as Environmental Chemistry (CHEM 341) and Forensic Science (CHEM 445)have a strong analytical focus, and make use of a wide range of instrumental methods in the laboratory.

5.9 a. Are any classes required for student certification taught wholly online? Yes ☐ No ☒

b. If you are having problems or concerns with the arrangements for these courses, please describe them.

Section 6: Undergraduate Research

6.1 Undergraduate Research

a. Do you use undergraduate research to fulfill certification requirements for lab hours?

Yes ☒ No ☐

b. Do you use undergraduate research to fulfill certification requirements for in-depth course work?

Yes ☒ No ☐

If yes to either question above, is a comprehensive written report required? Yes ☒ No ☐
If no, go to Item 6.3

6.2 Submit a sample of the comprehensive student research reports or theses representative of multiple disciplines and faculty, with the grade the student received indicated on each report. Also indicate on each report the number of terms (semesters or quarters) and actual student hours per term of research covered by the report.

Number submitted 4 (3-5 reports, 5 maximum)

6.3 Report on the participation in undergraduate research during the last five years.

a. Number of undergraduate majors (all degrees offered by your program) who participated in a research experience: 45

b. Number of chemistry faculty who were regularly involved in research with undergraduates: 7

6.4 If undergraduate research done outside of your institution is used to satisfy certification requirements, are students required to submit a comprehensive written research report that a faculty member at your institution evaluates and approves?

Yes ☒ No ☐ Not applicable ☐

6.5 How are students provided with experiment-specific safety education and training?

In coursework, student receive safety instruction from the instructor prior to beginning each experiment. Students also prepare research proposals in Junior Seminar (CHEM 395) which include sections on experimental methods and laboratory safety. These proposals are reviewed by the department chair and faculty supervisor prior to approval. Students must complete an appropriate safety training program with the laboratory manager, then receive additional safety instruction from the faculty supervisor.

Section 7: Student Skills

7.1 Describe the experiences that develop student professional skills in problem-solving, oral/written/presented communication, teamwork, and ethics (responsible scientific conduct).

While each of these skills is developed in multiple courses throughout the curriculum, problem solving, communication, and ethics are most thoroughly focused on in the CHEM 395, CHEM 495, and CHEM 499 research sequence. In CHEM 395, a research proposal is developed, presented, and revised based on feedback from faculty and other students. Experimental design, and research ethics are also addressed in this course. IN CHEM 495, research is conducted under the close supervision of a faculty mentor. In CHEM 499, The results of the research are presented publicly through a poster symposium, an oral presentation, and a written paper. Teamwork and team problem solving are developed throughout the curriculum through group exercises both in classes and in laboratories.

7.2 Describe how your students gain experience with the effective retrieval and use of chemical literature, data management, archiving, and record-keeping.

Retrieval and use of the chemical literature is taught early in the curriculum beginning with CHEM 225 (typicall fall semester sophomore year). Record keeping is similarly taught thoughout the curriculum through the instruction on and use of proper laboratory notebooks. While laboratory notebooks for coursework are typically not archived, laboratory notebooks, electronic data, and final products for research projects are archived indefinitely (electronic files are backed up on an external server). Additional specific instruction on data management etc. is provided during the undergraduate research sequence.

7.3 Describe how your program conveys safe lab practices and safety risk assessment to students throughout their undergraduate experience. When and where is the first safety instruction delivered?

Safety is taught throughout the curriculum beginning with CHEM 115. At the beginning of each course, a standardized laboratory safety handout is distributed to the students, and safe practices are described by the instructor. Students then sign a form acknowledging they have received general laboroatory safety instruction and the signatures are archived. Instructors also provide additional safety instruction at the beginning of each lab on potential hazards of that days experiment. Students conducting research and student employees must watch a series of videos annually, and pass a safety quiz in addition to receiving specific safety training from the faculty mentor or supervisor.

7.4 How are all of the student skills describe in Items 7.1, 7.2, and 7.3 assessed?

These skills are assessed both qualitatively and quantitatively through a variety of techniques, but the most effective assessment technique involvesobservation and quantitative assessment of students engaging in undergraduate research. Use of the chemical literature is assessed in CHEM 395 Jumior Seminar. During CHEM 495 Senior Project, individual faculty members assess student progress as the research is being executed (including safety, with feedback from routine safety inspections). In CHEM 499 (Senior Thesis) the faculty as a whole provide feedback on the oral and poster presentations, whicle the written paper is evaluated by the faculty mentor and the course instructor.

Section 8: Program Self-Evaluation

8.1 Describe the program self-evaluation activities that your department has undertaken over the past five years. Provide quantitative information, if available.

Lake Superior State University requires comprehensive program review to occur on a regular 5 year rotating schedule. The BS Chemistry & Biochemistry (including secondary ed) degrees were reviewed during the 2013-2014 academic year, while the Forensic Chemistry was reviewed during the 2014-2015 avademic year. The program review documents enrollment trends, staffing levels, graduate placement, student satisfaction, the adequacy of facilities, the acheivement of program learning outcomes, and course level assessment. At LSSU, assessment data for course level and program level learning outcomes is archived in TracDat software. Many courses use ACS exams to evaluate student learning. For example, The past four semesters of general chemistry had class averages of 38.5, 35.7, 37.8, and 40.7 on the 1997 First Semester Exam (average 39.4). Discussions of curriculum items Each fall, the Chemistry Faculty meets to prioritize facilities and instrumentation aquisition and potential funding sources (including submissions to NSF-MRI). LSSU has a fund available to the sciences at the Deans level for replacement of equipment and Instrumentation, and these funds have been used to acquire several instruments designated as priorities by the faculty including a new electrochemical workstation, MP-AES, and Ion Chromatograph in the last two years. Currently, the department is investigating the possibility (and practicality) of acquiring cryogenic NMR to better support research and instruction in Organic Chemistry.

8.2 Describe how the results of your department's self-evaluations have been used to improve student learning, student skills, exploration of alternate pedagogies, and the effectiveness of the chemistry program.

Several changes have resulted from the self evaluation process. We have acquired several instruments over the past five years to better support student learning, undergraduate research, and faculty scholarship. We also recently expanded our computational chemistry facilities. We are currently working on curriculum changes to improve the physical chemistry sequesnce, increase student use of computational chemistry software, increase coverage of polymer chemistry, and exapnd the series of seminar courses such that students would take a seminar course in each year of study. The changes to the seminar sequence we expect to particularly improve development of student skills in use of the chemical literature, scientific writing, and career development. We are also working with the English department to explore the possibility of offering specialized course sections of second semester english compsition for STEM majors, with the goal of formally intruducing scientific writing in the freshman year. Other changes include the improvement of safety instruction, including the requirement that students working on undergraduate research projects undergo a more rigorous safety training process than in the past.

Final Comments

Please comment on (in as much detail as you wish) changes in the last five years in faculty, diversity initiatives, professional development, support personnel, facilities, capital equipment, curriculum, and any other items related to your program that you believe would be of interest to CPT. We are especially interested in any new programs you are about to undertake. Use additional sheets, if necessary. Please do not include actual self-evaluation documents or reports.

Over the past five years, we have added an additional full time staff memeber for lab prep and instrument maintenance and repair. We requested campus wide access to SciFinder, and received support from the administration to implement it in 2012. We requested, and were granted, an additional budget for instrument maintenance and replacement through the Deans Fund which totals ~$120,000 annually for the sciences. We added new instrumentation in electrochemistry (electrochemical workstation consiststing of a potentiostat, cell stand, various electrodes, and software) in 2014, which has been incorporated into the instrumental analysis course and undergraduate research. We are also currently investigating the addition of a cryogenic NMR. Additionally, we are pursuing severalcurriculum improvements as described in section 8.2. With regard to facilities, we were granted additional laboratory space in 2011, to support our SEM and to support additional faculty research. In 2014, the university increased annual professional development funds from $800 to $1000, and has also begun redistributing a portion of grant indirect cost revenues to the PI's and the Departments as additional professional development funds.

CHEM 499 Abstracts for Chemistry Majors
Spring 2018

Student: Jason B. Nichols
Major: Chemistry
Title: Investigation of stereospecific alkylation using chiral Evan's auxiliaries
Abstract: Evan's auxiliaries are oxazolidinone-based compounds that use a bulky, stereospecific alkyl group to directs the stereospecific addition of an adjacent group to produce stereospecific products. Evan's auxiliaries have been used to produce tertiary chiral centers in the past, however, quaternary chiral centers have not commonly been studied.[1] The goal of this research is to: develop an effective method to control the asymmetric formation of quaternary carbons using Evan's auxiliaries, to determine their utility and limitations, and to better understand the mechanisms involved.

Student: Christopher Savich
Major: Chemistry
Title: Synthesis of 6,7-Dialkoxy and 7-Alkyl 3,4-Dihydroquinazolines and Evaluation of their Antimicrobial Properties
Abstract: Microorganism growth and the resulting biofilms that accumulate around them are a continuous problem to the medical field, especially as antibiotic resistance continues to grow. Variously substituted 3,4-dihydroquinazolines, a class of bicyclic compounds consisting of one benzene ring fused to a second ring containing two nitrogen atoms, have shown in the past to have anti-microbial and biofilm inhibitory properties. The synthesis of various 6,7-dialkoxy- and 7-alkyl-3,4-dihydroquinazolines via novel methods involving the treatment of amides with trifluoromethanesulfonic anhydride in the presence of 2-chloropyridine and in situ-generated imines to produce 3,4-dihydroquinazolines is described herein. The results of the anti-microbial and anti-biofilm are discussed within along with the effects of structure on said anti-microbial and anti-biofilm testing.

Student: John Alexander Westenbarger
Major: Chemistry
Title: Analysis of Silver Recovery Techniques and the Reduction of Silver Wastes
Abstract: Silver is a precious metal that is commercially used in a variety of industries ranging from electronics and jewelry to scientific research in both medical and chemical fields of study. These studies frequently utilize hazardous solutions like silver nitrate, which can pose serious health risks to both humans and aquatic life. The silver ions in these solutions are precipitated out of solution as silver chloride, and are disposed of as a recovered chemical waste. For this research eight different silver recovery methods were evaluated as alternative treatments to traditional waste disposal processes. The recovered silver samples were analyzed using an MP-AES in order to determine the most efficient method. The average amount of recovered silver ranged from 40% to 100%. Based on these results, the most efficient methods utilized sodium borohydride (100% recovered), ammonium hydroxide (99% recovered), and formaldehyde (98% recovered) as reducing agents. Potential benefits from this research include the reduction of chemical wastes, disposal costs, potential environmental risks and the development of a standard operating procedure (SOP), allowing student employees to actively reduce laboratory chemical waste.

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One-pot triflic anhydride-mediated synthesis of 1,2-disubstituted 2-imidazolines from *N*-(2-haloethyl)amides and amines

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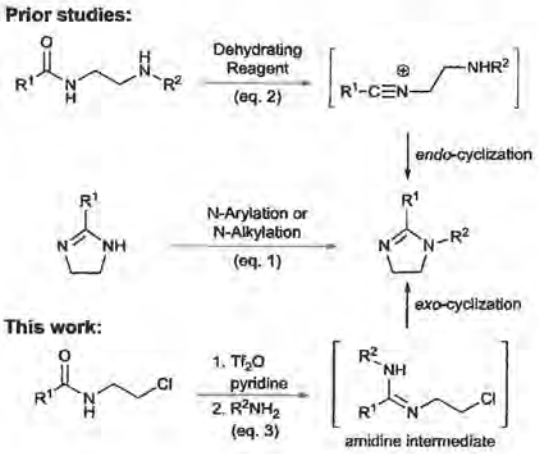
ABSTRACT

A one-pot synthesis of 1,2-disubstituted 2-imidazolines from *N*-(2-haloethyl)amides has been developed. The reaction affords high yields of diverse 1,2-disubstituted 2-imidazolines from triflic anhydride-mediated dehydration of amides followed by installation of a primary amine.

1. Introduction

2-Imidazolines are valuable compounds in medicinal chemistry due to their array of pharmacological activities.[1] Correspondingly, interest in this scaffold has resulted in numerous methods for its preparation.[2] The synthesis of 1,2-disubstituted 2-imidazolines in particular commonly involves initial synthesis of the core 2-imidazoline scaffold followed by N–H functionalization through treatment with activated alkylating reagents or via metal-mediated coupling reactions with aryl halides (e.g., eq. 1).[3] Alternatively, 1,2-disubstituted 2-imidazolines may be constructed through intramolecular *endo*-cyclization of *N*-(2-aminoethyl)amides, wherein the tethered amino groups are pre-functionalized with carbon substituents (eq. 2).[4] Reactions of this type typically rely on the use of phosphorus dehydrating reagents such as trimethylsilyl polyphosphate (PPSE)[5] and the Hendrickson reagent,[6] and these reactions may be promoted by microwave heating.[7] A complementary yet less frequently encountered strategy for 1,2-disubstituted 2-imidazoline formation under milder conditions involves intramolecular *exo*-cyclization by a nucleophilic amidine (e.g., eq. 3).[8] One major advantage of performing the *exo*-cyclization over the abovementioned *endo*-cyclization is that the substituted amino group does not need to be incorporated prior to conversion of the amide functionality. Therefore, the *exo*-cyclization strategy presents an opportunity to access the desired 1,2-disubstituted 2-imidazoline scaffold through reduced synthetic effort.



The amidine moiety is a basic functionality that is generated through a variety of methods, including dehydration of amides followed by introduction of an amine. Common reagents for amidine synthesis via amide dehydration include $SOCl_2$, PCl_5,

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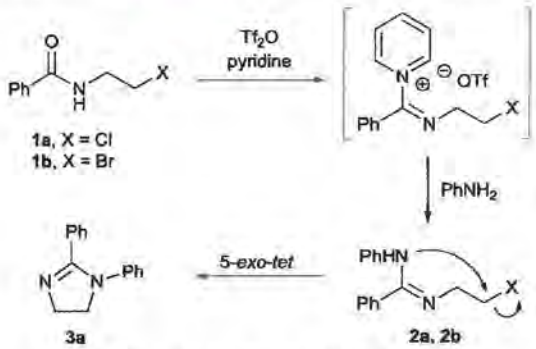
arylsulfonyl chlorides, and trifluoromethanesulfonic anhydride (Tf_2O).[9] Among these, Tf_2O has emerged as a stalwart reagent[10] for the preparation of amidines, as its use results in the generation of nonreactive triflate ions which are compatible with amines introduced subsequent to dehydration. Thus, isolation of the dehydration intermediates or removal of generated acids, as is necessary when using $SOCl_2$ or PCl_5, is not required, making Tf_2O a suitable reagent for use in one-pot multicomponent reactions. Consequently, Tf_2O has been innovatively used in many recent syntheses of amidine-containing molecules[11] including imidazolinium salts.[12] Herein, we report an operationally simple one-pot synthesis of 1,2-disubstituted 2-imidazolines via a Tf_2O-mediated reaction of *N*-(2-haloethyl)amides and primary amines.

2. Results and discussion

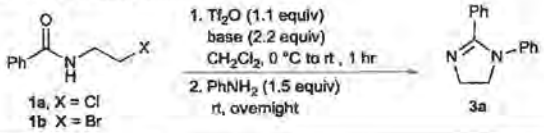
We initially envisioned the synthesis of 1,2-disubstituted 2-imidazolines to occur via the intramolecular 5-*exo*-*tet* cyclization of a halogen-tethered amidine. As such, the synthesis of haloamidine **2** was targeted, which we planned to generate from *N*-(2-haloethyl)amide **1** (Scheme 1). Chloroamide **1a** was synthesized by



Scheme 1. One-pot synthesis of 2-imidazolines.

benzoylation of commercially available 2-chloroethylamine·HCl. Successive treatment of **1a** with Tf_2O and pyridine followed by aniline rapidly resulted in the generation of **2a** (as monitored by TLC). To our delight, subsequent intramolecular cyclization then proceeded in the same reaction flask to provide the desired 2-imidazoline **3a** in 94% yield (Table 1, condition 1). The reaction yield was increased to 98% when performed on a multigram scale (Table 1, condition 2). A similar yield of **3a** was obtained when analogous bromoamide **1b** was prepared and used in the reaction (Table 1, condition 3). Other pyridine bases were screened in the reaction, which resulted in reduced product yields (Table 1, conditions 4–6). The Hendrickson reagent, also called the 'POP' reagent, is generated from Tf_2O and Ph_3PO and has been previously used for the synthesis of 2-imidazolines bearing electron poor nitrogen substituents (e.g., tosyl). Use of the Hendrickson reagent failed to provide good yields of **3a** (condition 7), which is consistent with reports of the reagent working poorly in the presence of electron rich amines.[10c] These initial results led us to pursue the use of *N*-(2-chloroethyl)amides for the syntheses of additional 2-imidazolines under optimized reaction parameters (condition 1).

Table 1
Optimization of reaction conditions



Conditions	Amide	Base	Yield (%)[b]
1	**1a**	Pyridine	94
2	**1a**	Pyridine	98
3	**1b**	Pyridine	97
4	**1a**	2-Chloropyridine	72
5	**1a**	2-Fluoropyridine	39
6	**1a**	4-(Dimethylamino)pyridine	0
7	**1a**	Pyridine	Trace

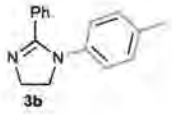
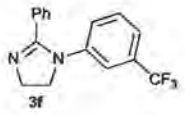
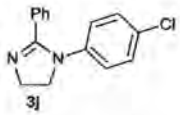
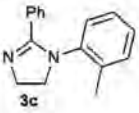
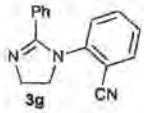
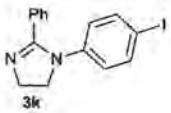
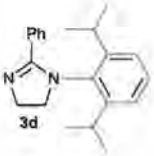
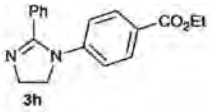
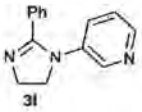
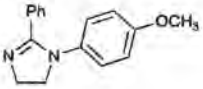
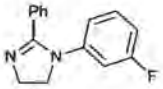
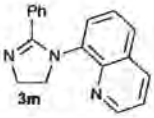
[a] Reaction conditions: amide **1a** or **1b** (2 mmol), base (4.4 mmol), Tf_2O (2.2 mmol), CH_2Cl_2 (6 mL), 0 °C to rt, then $PhNH_2$ (3 mmol), rt, overnight.
[b] Yield of isolated product.
[c] Reaction performed on 10 mmol scale.
[d] Reaction conditions: Tf_2O (1 mmol), Ph_3PO (2 mmol), CH_2Cl_2, 0 °C, 30 min, then **1a** (0.8 mmol), pyridine (1 mmol), rt, 1 h, then $PhNH_2$, rt, overnight.

Exploration of the reaction scope initiated with the synthesis of 1,2-diaryl 2-imidazolines, which were prepared through the introduction of a variety of commercially available aryl amines. Treatment of **1a** with Tf_2O and pyridine followed by exposure to an appropriate aniline derivative led to the formation of corresponding 2-phenyl-2-imidazolines in high yields (Table 2). Alkyl-substituted anilines were readily incorporated into 2-imidazolines (entries 1–3), including sterically bulky diisopropylaniline (entry 3). Likewise, anilines decorated with electron donating (entry 4) and electron withdrawing substituents (entries 5–7) were introduced in high yields. 2-Imidazolines comprising halogenated aniline units were also successfully prepared in high yields (entries 8–10). Finally, the reaction allowed for the introduction of heteroaromatic substituents, as demonstrated through the use of 3-aminopyridine (entry 11) and 8-aminoquinoline (entry 12).

The reaction also proved useful for the synthesis of 2-imidazolines bearing diverse C2 substituents. 2-Imidazolines of this type were synthesized from corresponding *N*-(2-chloroethyl) amides **4a–k**, which were readily prepared from 2-chloroethylamine·HCl through treatment with an appropriate acid chloride under basic conditions or via DIC coupling with an appropriate carboxylic acid. The amides were submitted to ring formation conditions with aniline as the nucleophilic amine to generate the corresponding *N*-phenyl-2-imidazolines in moderate to high yields (Table 3). Electron rich benzamides were transformed into the corresponding 2-imidazolines in excellent yields (entries 1–3). Electron withdrawing C2 substituents were tolerated in the reaction, albeit 2-imidazolines were formed in slightly lower yields (entries 4–5). Haloarene-substituted and heteroatom-substituted 2-imidazolines were also prepared in moderate to good yields (entries 6–7 and 8, respectively). Alkanamides were efficiently transformed into C2-alkyl substituted 2-imidazolines (entries 9–11) with slight drops in reaction yield being observed with increasing alkyl branching. Lastly, the ability to incorporate multiple bulky substituents was explored through the synthesis of compounds **6** and **7**, which were afforded in good to high yields.

The synthesis of *N*-alkyl-substituted 2-imidazolines was also explored using our protocol. Dehydration of amide **1a** followed by introduction of alkyl amines resulted in the generation of *N*-alkyl-2-imidazolines in good yields (Table 4). In general, *N*-alkyl-2-imidazolines were prepared in reduced yields compared to *N*-aryl-2-imidazolines. Benzylamine and substituted benzylamines were readily introduced without issue (entries 1–3). The benzyl substituents represent handles that may be readily removed. Similarly, the installation of propargylamine was tolerated (entry 4). However, no 2-imidazoline product was obtained when *tert*-butyl amine was used in the reaction (entry 5). This result was surprising, especially since diphenylmethanamine was so readily incorporated into the 2-imidazoline scaffold (entry 3). We reasoned that the *tert*-butyl amine was too bulky to approach the reactive imidoyl

Table 2
Reaction scope varying *N*-aryl substituents through addition of aryl amines

Entry	2-Imidazoline	Yield (%)[b]	Entry	2-Imidazoline	Yield (%)[b]	Entry	2-Imidazoline	Yield (%)[b]
1	 **3b**	80	5	 **3f**	95	9	 **3j**	93
2	 **3c**	88	6	 **3g**	99	10	 **3k**	94
3	 **3d**	90	7	 **3h**	97	11	 **3l**	89
4	 **3e**	83	8	 **3i**	88	12	 **3m**	88

[a] Conditions: **1a** (1.0 equiv), pyridine (2.2 equiv), Tf_2O (1.1 equiv), CH_2Cl_2, 0 °C to rt, 1 h, then aryl amine (1.5 equiv), rt, overnight.
[b] Yield of isolated product.

intermediate generated from dehydration of the amide. Previous studies have demonstrated that dehydration of amides with Tf_2O and less basic 2-fluoropyridine leads to the generation of nitrilium ions.[17] We postulated that a nitrilium ion would be better positioned to accept the bulky nucleophile during 2-imidazoline formation. Indeed, the use of 2-fluoropyridine instead of pyridine resulted in the synthesis of **8e** in 25% yield (data not shown). The yield was further increased to 79% by using 2-fluoropyridine and increasing the temperature of the reaction (reflux, entry 6). Lastly, 2-imidazoline **9** was prepared from the corresponding alkanamide to demonstrate the ability to incorporate alkyl substituents at both the N1 and C2 positions (entry 7).

The reaction is believed to proceed through a haloamidine intermediate (e.g., **2**), which would undergo a 5-*exo-tet* cyclization to furnish the 2-imidazoline product (Scheme 1). However, as many known 2-imidazaoline syntheses proceed via intramolecular attack by an amine through an *endo*-cyclization process (e.g., eq. 2), we sought to determine whether such a cyclization was possible under our reaction conditions (Scheme 2). To test the plausible 5-*endo-trig* cyclization, amino amide **10** was prepared[14d] and treated with Tf_2O and pyridine. The reaction produced no 2-imidazoline product after stirring at room temperature overnight, indicating that our product yields are primarily representative of reactions proceeding via 5-*exo-tet* cyclization. While the 5-*endo-trig* cyclization was unsuccessful, we anticipated that a related 5-*endo-dig* cyclization would afford the desired 2-imidazoline product. Thus, compound **10** was submitted to similar reaction conditions employed for the synthesis of **8e**, wherein 2-fluoropyridine was used as a substitute for pyridine, and the reaction provided **3a** in 59% yield. The formation of 2-imidazoline product after the switch from pyridine to 2-fluoropyridine likely resulted from the reaction proceeding through a nitrilium intermediate (**11**), which allows for a favorable 5-*endo-dig* cyclization.

In conclusion, we report here the efficient synthesis of 1,2-disubstituted 2-imidazolines via a one-pot two-step reaction of halogen-tethered amides with Tf_2O and pyridine followed by addition of a primary amine. The reaction is tolerant of a variety of functional groups and provides diverse 1,2-disubstituted 2-imidazolines in high yields.

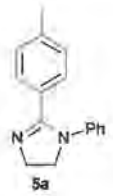
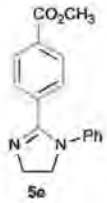
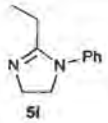
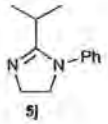
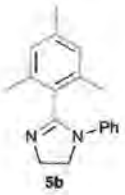
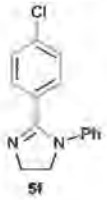
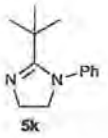
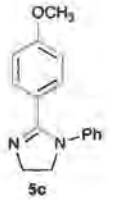
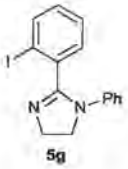
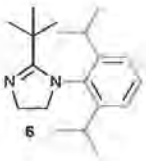
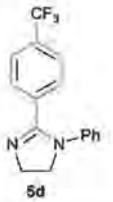
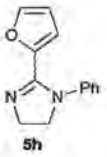
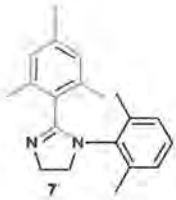
3. Experimental

3.1. General

Reactions were carried out in flame-dried glassware under nitrogen atmosphere. All reactions were magnetically stirred and monitored by TLC on EMD Millipore silica gel $60F_{254}$ pre-coated glass plates using either UV light (254 nm) or basic aqueous $KMnO_4$ stain to visualize the compounds. Column chromatography was carried out on SiliaFlash P60 (230–400 mesh) silica gel supplied by SiliCycle. Infrared spectra were recorded on a Perkin Elmer Spectrum 100 FTIR spectrometer. Proton (^{1}H NMR) and carbon (^{13}C NMR) nuclear magnetic resonance spectra were recorded at the Max T. Rogers NMR facility of Michigan State University on a Varian Inova-500 spectrometer and an Agilent DDR2 500 MHz spectrometer and at the Lumigen Instrument Center of Wayne State University on a Bruker 700 MHz spectrometer. The chemical shifts are given in parts per million (ppm) on the δ (δ) scale. The residual solvent peak was used as a reference value.[18] High resolution mass spectra were recorded at the Lumigen Instrument Center of Wayne State University on a Waters LCT Premium XE spectrometer. Melting points were obtained using a Mel-Temp capillary melting point apparatus and are uncorrected. CH_2Cl_2 was distilled under N_2 from CaH_2; all other solvents were used without additional purification. All other chemicals, unless otherwise noted, were purchased from commercial vendors and were used without additional purification.

3.1.1. General procedure for N-(2-haloethyl)amide synthesis. To a mixture of either 2-chloroethylamine·HCl or 2-

Table 3
Reaction scope varying the C2-substituent in reaction with aniline

Entry	2-Imidazoline[a]	Yield (%)[b]	Entry	2-Imidazoline[a]	Yield (%)[b]	Entry	2-Imidazoline[a]	Yield (%)[b]
1	 **5a**	98	5	 **5e**	81	9	 **5i**	99
						10	 **5j**	98
2	 **5b**	96	6	 **5f**	83	11	 **5k**	96
3	 **5c**	94	7	 **5g**	77	12	 **6**	96
4	 **5d**	80	8	 **5h**	78	13	 **7**	86

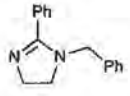
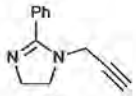
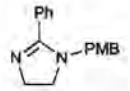
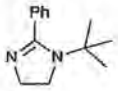
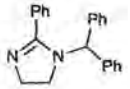
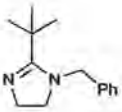
[a] Conditions: *N*-(2-chloroethyl)amide (1.0 equiv), pyridine (2.2 equiv), Tf_2O (1.1 equiv), CH_2Cl_2, 0 °C to rt, 1 h, then aniline (1.5 equiv), rt, overnight.
[b] Yield of isolated product.
[c] 2,6-Diisopropylaniline used instead of aniline.
[d] 2,6-Dimethylaniline used instead of aniline.

bromoethylamine·HBr and TEA in anhydrous CH_2Cl_2, cooled to 0 °C in an ice bath, was added dropwise an appropriate acid chloride or acid anhydride followed by 4-DMAP (for the indicated compounds). The ice bath was removed and the reaction stirred under N_2 atmosphere until complete, as determined by TLC. The reaction was washed successively with 1 M HCl, saturated $NaHCO_3$, and brine before being dried (Na_2SO_4) and concentrated. The crude product was then purified either by crystallization or silica gel chromatography.

*3.1.2. N-(2-Chloroethyl)benzamide (**1a**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (3.480 g, 30.0 mmol), TEA (4.19 mL, 30.0 mmol), benzoyl chloride (4.18 mL, 36.0 mmol) and CH_2Cl_2 (150 mL). The reaction stirred for 4 h and was washed and dried as described previously. The filtrate was concentrated and purified via crystallization from EtOAc and hexanes to afford 5.070 g (92% yield) of the title compound as a white solid (mp=100–104 °C). The NMR spectral data[14] and melting point data (lit. Mp=105–106 °C)[15] are consistent with those reported in the literature.

*3.1.3. N-(2-Bromoethyl)benzamide (**1b**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-bromoethylamine HBr (4.099 g, 20.0 mmol), TEA (5.6 mL, 40 mmol), CH_2Cl_2 (100 mL), benzoic anhydride (4.525 g, 20.0 mmol), and DMAP (0.125 g, 1.02 mmol). The reaction stirred for 3 h and was washed and dried as described previously. The filtrate was concentrated and purified via crystallization from EtOAc and hexanes to afford 1.012 g (22% yield) of the title compound as a white solid (mp=106–108 °C). ^1H NMR (500 MHz, $CDCl_3$) δ 3.60 (t, J=5.8 Hz, 2H), 3.88 (q, J=5.8 Hz, 2H), 6.61 (broad s, 1H), 7.45 (t, J=7.5 Hz, 2H), 7.52 (t, J=7.4 Hz, 1H), 7.77–7.81 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.5,

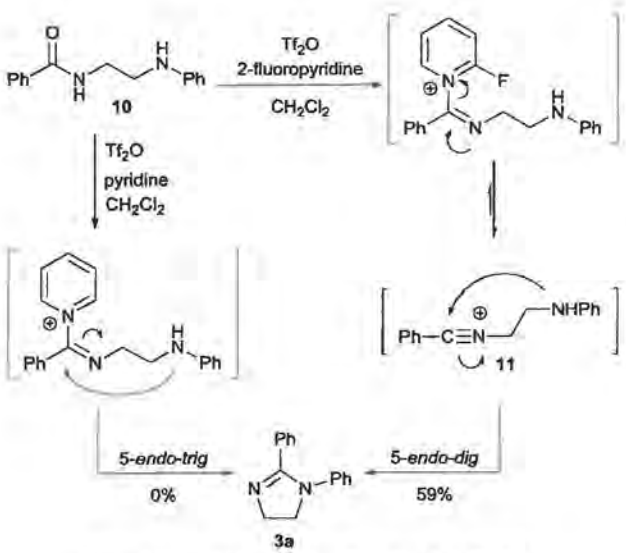
Table 4
Scope of *N*-alkyl 2-imidazoline synthesis

Entry	2-Imidazoline	Yield (%)	Entry	2-Imidazoline	Yield (%)
1	 **8a**	76	4	 **8d**	77
2	 **8b**	77	5 6	 **8e**	0 79
3	 **8c**	81	7	 **9**	97

[a] Conditions: **1a** (1.0 equiv), pyridine (2.2 equiv), Tf_2O (1.1 equiv), CH_2Cl_2, 0 °C to rt, 1 h, then amine (1.5 equiv), rt, overnight.
[b] Yield of isolated product.
[c] Conditions: **1a** (1.0 equiv), 2-fluoropyridine (2.2 equiv), Tf_2O (1.1 equiv), CH_2Cl_2, 0 °C to rt, 1 h, then $^tBuNH_2$ (1.5 equiv), reflux, overnight.
[d] *N*-(2-chloroethyl)-2,2-dimethylpropanamide used as amide.

134.1, 131.7, 128.6, 127.0, 41.5, 32.7; IR (neat) 3305, 3065, 1634, 1542, 1302, 1175 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_9H_{11}BrNO$ [M+H], 228.0024; found, 228.0021. The melting point data is consistent with the literature value (lit. Mp=104–105 °C).[18]

3.1.4. N-(2-Chloroethyl)-4-methylbenzamide (**4a**). Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (1.162 g, 10.0 mmol), TEA (2.80 mL, 20.1 mmol), 4-methylbenzoyl chloride (1.32 g, 9.98 mmol) and CH_2Cl_2 (50 mL). The reaction stirred for 3 h and was washed and dried as described previously. The filtrate was concentrated and purified via crystallization from EtOAc and hexanes to afford 1.130 g (57% yield) of the title compound as a white solid (mp=122–125 °C). ^1H NMR (500 MHz, $CDCl_3$) δ 2.39 (s, 3H), 3.71 (t, J=5.2 Hz, 2H), 3.78 (q, J=5.6 Hz, 2H), 6.69 (broad s, 1H), 7.23 (d, J=7.9 Hz, 2H), 7.68 (d, J=8.2 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.6, 142.2, 131.1, 129.2, 126.9, 44.1, 41.6, 21.4; IR (neat) 3321, 1643, 1540, 1505, 1252, 1183 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{10}H_{13}ClNO$ [M+H], 198.0686; found, 198.0680.



Scheme 2. 2-Imidazonline formation via *endo* cyclization.

3.1.5. N-(2-Chloroethyl)-2,4,6-trimethylbenzamide (**4b**). Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (1.168 g, 10.1 mmol), TEA (2.80 mL, 20.1 mmol), 2,4,6-trimethylbenzoyl chloride (1.70 mL, 10 mmol) and CH_2Cl_2 (50 mL). The reaction stirred for 4 h and was washed and dried as described previously. The filtrate was concentrated and purified via crystallization from EtOAc and hexanes to afford 0.873 g (38% yield) of the title compound as a white solid (mp=120–122 °C). ^1H NMR (500 MHz, $CDCl_3$) δ 2.27 (s, 9H), 3.70–3.76 (m, 4H), 6.19 (broad s, 1H), 6.83 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 170.7, 138.5, 134.4, 134.1, 128.2, 43.9, 41.3, 21.0, 19.0; IR (neat) 3235, 3062, 2859, 1631, 1611, 1547, 1447, 1312, 1186 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{12}H_{17}ClNO$ [M+H], 226.0999; found, 226.0994.

3.1.6. N-(2-Chloroethyl)-4-methoxybenzamide (**4c**). Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (2.322 g, 20.0 mmol), TEA (5.60 mL, 40.2 mmol), 4-methoxybenzoyl chloride (3.578 g, 21.0 mmol) and CH_2Cl_2 (50 mL). The reaction stirred for 4 h and was washed and dried as described previously. The filtrate was concentrated and purified by silica gel chromatography (50%–100% EtOAc in hexanes as eluent) to afford 1.427 g (33% yield) of the title compound as a white solid (mp=129–131 °C). ^1H NMR (500 MHz, $CDCl_3$) δ 3.70 (t, J=5.2 Hz, 2H), 3.76 (q, J=5.7 Hz, 2H), 3.83 (s, 3H), 6.67 (broad s, 1H), 6.91 (d, J=8.8 Hz, 2H), 7.75 (d, J=8.8 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.1, 162.3, 128.8, 126.2, 113.7, 55.4, 44.1, 41.6; IR (neat) 3283, 3018, 1634, 1607, 1500, 1256, 1185 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{10}H_{13}ClNO_2$ [M+H], 214.0635; found, 214.0634.

3.1.7. N-(2-Chloroethyl)-4-trifluoromethylbenzamide (**4d**). Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (2.342 g, 20.2 mmol), TEA (5.60 mL, 40.1 mmol), 4-(trifluoromethyl)benzoyl chloride (2.97 mL, 20.0 mmol) and CH_2Cl_2 (100 mL). The reaction stirred for 3 h and was washed and dried as described previously. The filtrate was purified via crystallization from EtOAc and hexanes afford 2.597 g (52% yield) of the title compound as a white solid (mp=101–105 °C). ^1H NMR (500 MHz, $CDCl_3$) δ 3.74 (t, J=5.5 Hz, 2H), 3.81 (q, J=5.3 Hz, 2H), 6.76 (broad s, 1H) 7.69 (d, J=8.1 Hz, 2H), 7.89 (d, J=8.1 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.4, 137.3, 133.4 (q, $^2J_{C-F}$=32 Hz), 127.5, 125.7 (q, $^3J_{C-F}$=4 Hz), 123.6 (q, $^1J_{C-F}$=273 Hz), 43.8, 41.8; IR (neat) 3236, 3070, 1630, 1563, 1323, 1156, 1121, 1066 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{10}H_{10}ClF_3NO$ [M+H], 252.0403; found, 252.0397.

3.1.8. Methyl 4-[(2-chloroethyl)carbamoyl]benzoate (**4e**). To a solution of monomethyl terephthalate (0.993 g, 5.51 mmol), 2-chloroethylamine HCl (0.576 g, 4.97 mmol), TEA (0.70 mL, 5.0 mmol), and *N*-hydroxysuccinimide (0.576 g, 5.00 mmol) in CH_2Cl_2 (6.5 mL), cooled in an ice bath, was added dropwise diisopropyl carbodiimide (0.97 mL, 6.3 mmol). The ice bath was removed and the reaction stirred under N_2 atmosphere overnight. The reaction mixture was washed successively with aqueous 1.0 M HCl solution and brine before being dried (Na_2SO_4) and concentrated. Purification via silica gel chromatography (40%–50% EtOAc

in hexanes as eluent) afforded 0.564 g (47% yield) of the title compound as a white solid (mp=116–118 °C). The NMR spectral data and melting point data (lit. Mp=123 °C) are consistent with those reported in the literature.[19]

*3.1.9. N-(2-Chloroethyl)-4-chlorobenzamide (**4f**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (1.161 g, 10.0 mmol), TEA (2.80 mL, 20.1 mmol), 4-chlorobenzoyl chloride (1.747 g, 9.98 mmol) and CH_2Cl_2 (50 mL). The reaction stirred for 4 h and was washed and dried as described previously. The filtrate was concentrated and purified by silica gel chromatography (50%–100% EtOAc in hexanes as eluent) to afford 1.226 g (56% yield) of the title compound as a white solid (mp=107–108 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.71 (t, J=5.1 Hz, 2H), 3.77 (q, J=5.7 Hz, 2H), 6.76 (broad s, 1H), 7.39 (d, J=8.5 Hz, 2H), 7.72 (d, J=8.5 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.6, 138.0, 132.3, 128.8, 128.4, 43.9, 41.7; IR (neat) 3296, 3077, 1626, 1599, 1546, 1488, 1326, 1093 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_9H_{10}Cl_2NO$ [M+H], 218.0139; found, 218.0136.

*3.1.10. N-(2-Chloroethyl)-2-iodobenzamide (**4g**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (1.937 g, 16.7 mmol), TEA (2.20 mL, 15.7 mmol), 2-iodobenzoyl chloride (2.11 g, 9.3 mmol) and CH_2Cl_2 (50 mL). The reaction stirred overnight and was washed and dried as described previously. The filtrate was concentrated and purified by a silica plug (75% EtOAc in hexanes) followed by crystallization from EtOAc and hexanes to afford 1.248 g (43% yield) of the title compound as a white solid (mp=96–100 °C). The NMR spectral data and melting point data (lit. Mp=102–104 °C) are consistent with those reported in the literature.[20]

*3.1.11. N-(2-Chloroethyl)furan-2-carboxamide (**4h**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (0.550 g, 4.74 mmol), TEA (1.20 mL, 8.59 mmol), 2-furoyl chloride (0.559 g, 4.28 mmol) and CH_2Cl_2 (10 mL). The reaction stirred overnight and was washed and dried as described previously. The filtrate was concentrated and purified by silica gel chromatography (50% EtOAc in hexanes) followed by crystallization from EtOAc and hexanes to afford 0.172 g (23% yield) of the title compound as a white needle-like solid (mp=68–72 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.68 (t, J=5.5 Hz, 2H), 3.76 (q, J=5.6 Hz, 2H), 6.49 (dd, J=3.5, 1.7 Hz, 1H), 6.84 (broad s, 1H), 7.11 (dd, J=3.4, 0.8 Hz, 1H), 7.44 (dd, J=1.9, 0.8 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.4, 147.5, 144.1, 114.6, 112.1, 43.8, 40.8; IR (neat) 3256, 2964, 1644, 1591, 1533, 1476, 1430, 1302, 1195 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_7H_9ClNO_2$ [M+H], 174.0322; found, 174.0328.

*3.1.12. N-(2-Chloroethyl)propanamide (**4i**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (1.168 g, 10.1 mmol), TEA (2.80 mL, 20.1 mmol), propionic anhydride (1.30 mL, 10 mmol), 4-DMAP (0.114 g, 0.933 mmol), and CH_2Cl_2 (50 mL). The reaction stirred for 2 h and was washed and dried as described previously. The filtrate was concentrated and purified by silica gel chromatography (50% EtOAc in hexanes as eluent) to afford 0.684 g (50% yield) of the title compound as a colorless oil. The NMR spectral data is consistent with those reported in the literature.[21]

*3.1.13. N-(2-Chloroethyl)-2-methylpropanamide (**4j**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (2.325 g, 20.0 mmol), TEA (5.70 mL, 40.8 mmol), isobutyryl chloride (2.20 mL, 21.0 mmol), 4-DMAP (0.122 g, 1.00 mmol), and CH_2Cl_2 (50 mL). The reaction stirred overnight and was washed and dried as described previously. The filtrate was concentrated and purified by silica gel chromatography (50%–100% EtOAc in hexanes as eluent) to afford 1.410 g (53% yield) of the title compound as a white solid (mp=44–47 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.15 (d, J=6.9 Hz, 6H), 2.38 (hept, J=6.9 Hz, 1H), 3.55–3.63 (m, 4H), 6.00 (broad s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.2, 44.1, 41.0, 35.5, 19.5; IR (neat) 3286, 2972, 1646, 1548, 1240 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_6H_{13}ClNO$ [M+H], 150.0686; found, 150.0680.

*3.1.14. N-(2-Chloroethyl)-2,2-dimethylpropanamide (**4k**).* Prepared according to the general procedure for *N*-(2-haloethyl)amide synthesis using 2-chloroethylamine hydrochloride (2.388 g, 20.6 mmol), TEA (5.60 mL, 40.2 mmol), trimethylacetyl chloride (2.50 mL, 20.4 mmol), 4-DMAP (0.070 g, 0.57 mmol) and CH_2Cl_2 (100 mL). The reaction stirred overnight and was washed and dried as described previously. The filtrate was concentrated and purified via crystallization from EtOAc and hexanes to afford 1.597 g (47% yield) of the title compound as white solid (mp=61–64 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.19 (s, 9H), 3.54–3.63 (m, 4H), 6.10 (br s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 178.6, 44.1, 41.1, 38.7, 27.5; IR (neat) 3347, 2971, 1640, 1527, 1206 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_7H_{15}ClNO$ [M+H], 164.0842; found, 164.0834.

3.1.15. General procedure for 2-imidazoline synthesis. A solution of appropriate *N*-(2-haloethyl)amide (1 equiv) in CH_2Cl_2 was cooled in an ice bath and treated successively with pyridine (2.2 equiv) and triflic anhydride (1.1 equiv). The ice bath was removed and the reaction stirred under N_2 atmosphere for 1 h. An appropriate primary amine (1.5 equiv) was then added and the reaction stirred at room temperature overnight. The reaction was diluted with saturated $NaHCO_3$ solution and the biphasic mixture vigorously stirred for 30 min before being extracted with CH_2Cl_2 (×3). The pooled organic extracts were dried (Na_2SO_4) and concentrated, and the crude product was purified via silica gel chromatography. For larger scale reactions, azeotropic distillation of residual pyridine prior to performing silica gel chromatography was performed to simplify chromatographic separations.

*3.1.16. 1,2-Diphenyl-4,5-dihydro-1H-imidazole (**3a**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (1.838 g, 10.0 mmol), CH_2Cl_2 (12 mL), pyridine (1.70 mL, 22 mmol), triflic anhydride (2.00 mL, 12 mmol), and aniline (1.37 mL, 15 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (2.185 g, 98%) as a solid (mp=65–69 °C). The NMR spectral data[7b,22] and melting point data (lit. Mp=72–76 °C)[22] are consistent with those reported in the literature.

*3.1.17. 2-Phenyl-1-(4-methylphenyl)-4,5-dihydro-1H-imidazole (**3b**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.362 g, 1.97 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and *p*-toluidine (0.328 g, 3.06 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (96% EtOAc/4% TEA as eluent) to afford the desired product (0.375 g, 80%) as an oil. The NMR spectral data is consistent with those reported in the literature.[7b,23]

*3.1.18. 2-Phenyl-1-(2-methylphenyl)-4,5-dihydro-1H-imidazole (**3c**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.363 g, 1.98 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and *o*-toluidine (0.32 mL, 3.0 mmol). Following workup

and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.411 g, 88%) as a solid (mp=88–90 °C). The NMR spectral data and melting point data (lit. Mp=86 °C) are consistent with those reported in the literature.

*3.1.19. 1-[2,6-di(Propan-2-yl)phenyl]-2-phenyl-4,5-dihydro-1H-imidazole (**3d**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.364 g, 1.98 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and 2,6-diisopropylaniline (0.57 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.548 g, 90%) as a solid (mp=106–108 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 0.90 (d, J=6.8 Hz, 6H), 1.21 (d, J=6.9 Hz, 6H), 3.24 (septet, J=6.9 Hz, 2H), 3.79 (t, J=10.3 Hz, 2H), 4.11 (t, J=10.3 Hz, 2H), 7.09 (d, J=7.7 Hz, 2H), 7.14 (dd, J=8.2, 7.0 Hz, 2H), 7.21–7.27 (m, 2H), 7.41 (dd, J=8.4, 1.4 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 164.7, 147.3, 136.7, 130.3, 129.7, 128.4, 128.2, 127.7, 124.4, 55.4, 53.1, 27.9, 25.6, 23.2; IR (neat) 2962, 2863, 1598, 1570, 1449, 1391, 1265 cm^{-1}; HRMS (ESI): m/z calcd for $C_{21}H_{27}N_2$ [M+H], 307.2174; found, 307.2183.

*3.1.20. 2-Phenyl-1-(4-methoxyphenyl)-4,5-dihydro-1H-imidazole (**3e**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.368 g, 2.00 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and p-anisidine (0.376 g, 3.05 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (1%–4% TEA in EtOAc as eluent) to afford the desired product (0.421 g, 83%) as a solid (mp=70–72 °C). The NMR spectral data and melting point data (lit. Mp=70 °C) are consistent with those reported in the literature.

*3.1.21. 2-Phenyl-1-(3-trifluoromethylphenyl)-4,5-dihydro-1H-imidazole (**3f**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.370 g, 2.01 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and 3-(trifluoromethyl)aniline (0.37 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.557 g, 95%) as a solid (mp=30–34 °C). The NMR spectral data is consistent with those reported in the literature.

*3.1.22. 2-(2-Phenyl-4,5-dihydro-1H-imidazol-1-yl)benzonitrile (**3g**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.362 g, 1.97 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.38 mL, 2.2 mmol), and 2-aminobenzonitrile (0.362 g, 3.06 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.485 g, 99%) as an oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.99–4.12 (m, 4H), 7.34 (ddd, J=7.9, 6.1, 2.3 Hz, 1H), 7.47–7.51 (m, 3H), 7.54–7.60 (m, 2H), 7.61–7.65 (m, 2H), 8.03–8.07 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.5, 153.7, 146.7, 135.0, 133.1, 130.2, 128.7, 127.7, 127.2, 126.5, 125.2, 117.8, 53.4, 48.9; IR (neat) 3062, 2886, 2220, 1644, 1561, 1467, 1390 cm^{-1}; HRMS (ESI): m/z calcd for $C_{16}H_{14}N_3$ [M+H], 248.1188; found, 248.1178.

*3.1.23. 1-(4-Benzoic acid ethyl ester)-2-phenyl-4,5-dihydro-1H-imidazole (**3h**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.365 g, 1.99 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and ethyl 4-aminobenzoate (0.495 g, 3.00 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.570 g, 97%) as an oil. The NMR spectral data is consistent with those reported in the literature.

*3.1.24. 2-Phenyl-1-(3-fluorophenyl)-4,5-dihydro-1H-imidazole (**3i**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.316 g, 1.72 mmol), CH_2Cl_2 (6 mL), pyridine (0.29 mL, 3.8 mmol), triflic anhydride (0.33 mL, 2.0 mmol), and 3-fluoroaniline (0.25 mL, 2.6 mmol). Following workup, which was modified to include washing with 1 M NaOH solution instead of satd $NaHCO_3$ solution, and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.363 g, 88%) as an oil. The NMR spectral data is consistent with those reported in the literature.

*3.1.25. 2-Phenyl-1-(4-chlorophenyl)-4,5-dihydro-1H-imidazole (**3j**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.367 g, 2.00 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and 4-chloroaniline (0.381 g, 2.99 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.475 g, 93%) as a solid (mp=94–96 °C). The NMR spectral data is consistent with those reported in the literature.

*3.1.26. 2-Phenyl-1-(4-iodophenyl)-4,5-dihydro-1H-imidazole (**3k**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.363 g, 1.98 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.38 mL, 2.2 mmol), and 4-iodoaniline (0.656 g, 3.00 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.648 g, 94%) as a solid (mp=130–132 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.98–4.11 (m, 4H), 6.52 (d, J=8.8 Hz, 2H), 7.29–7.34 (m, 2H), 7.39 (tt, J=7.4 Hz, 1.3 Hz, 1H), 7.42–7.50 (m, 4H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.9, 142.7, 137.6, 130.8, 130.1, 128.5, 128.3, 123.9, 86.2, 53.6, 53.0; IR (neat) 3017, 2971, 1582, 1574, 1484, 1375, 1217 cm^{-1}; HRMS (ESI): m/z calcd for $C_{15}H_{14}IN_2$ [M+H], 349.0202; found, 349.0205.

*3.1.27. 3-(2-Phenyl-4,5-dihydro-1H-imidazol-2-yl)pyridine (**3l**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.367 g, 2.00 mmol), CH_2Cl_2 (8 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and 3-aminopyridine (0.282 g, 3.00 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (1–5% TEA in EtOAc as eluent) to afford the desired product (0.397 g, 89%) as an oil. The NMR spectral data is consistent with those reported in the literature.

*3.1.28. 8-(2-Phenyl-4,5-dihydro-1H-imidazol-2-yl)quinoline (**3m**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.366 g, 1.99 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and 8-aminoquinoline (0.433 g, 3.00 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.477 g, 88%) as a solid (mp=141–143 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.20 (s, 4H), 7.08 (dd, J=7.4, 1.3 Hz, 1H), 7.13 (t, J=7.7 Hz, 2H), 7.22 (t, J=7.4 Hz, 1H), 7.27 (t, J=7.8 Hz, 1H), 7.41 (dd, J=8.3, 4.2 Hz, 1H), 7.47–7.50 (m, 2H), 7.58 (dd, J=8.2, 1.3 Hz, 1H), 8.13 (dd, J=8.2, 1.8 Hz, 1H), 8.95 (dd, J=4.2,

1.8 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 165.0, 149.7, 143.8, 141.9, 136.2, 131.2, 129.6, 129.3, 128.4, 127.8, 126.3, 126.1, 125.3, 121.5, 55.4, 54.1; IR (neat) 2925, 2861, 1593, 1492, 1368, 1272 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{18}H_{16}N_3$ [M+H], 274.1344; found, 274.1349.

*3.1.29. 2-(4-Methylphenyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5a**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4a** (0.401 g, 2.03 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.470 g, 98%) as an oil. The NMR spectral data is consistent with those reported in the literature.[16]

*3.1.30. 2-(2,4,6-Trimethylphenyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5b**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4b** (0.440 g, 1.95 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.496 g, 96%) as a solid (mp=152–154 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 2.13 (s, 6H), 2.28 (s, 3H), 3.96–4.09 (m, 4H), 6.59 (dt, *J*=7.8, 1.1 Hz, 2H), 6.82 (s, 2H), 6.86 (tt, *J*=7.5, 1.1 Hz, 1H), 7.05–7.10 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.2, 140.7, 138.6, 136.1, 129.1, 128.6, 128.3, 121.7, 117.4, 52.5, 50.0, 21.2, 19.4; IR (neat) 3056, 2867, 1618, 1596, 1374, 1259 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{18}H_{21}N_2$ [M+H], 265.1705; found, 265.1715.

*3.1.31. 2-(4-Methoxyphenyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5c**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4c** (0.429 g, 2.01 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.475 g, 94%) as a solid (mp=74–76 °C). The NMR spectral data is consistent with those reported in the literature.[22]

*3.1.32. 2-(4-Trifluoromethylphenyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5d**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4d** (0.500 g, 1.99 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.463 g, 80%) as a solid (mp=75–77 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.05–4.09 (m, 4H), 6.78 (dd, *J*=8.5, 1.0 Hz, 2H), 7.02 (t, *J*=7.4 Hz, 1H), 7.16–7.21 (m, 2H), 7.53 (d, *J*=8.2 Hz, 2H), 7.61 (d, *J*=8.1 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.5, 142.7, 134.7, 131.6 (q, $^2J_{C-F}$=33 Hz), 129.0, 128.9, 125.1 (q, $^3J_{C-F}$=4 Hz), 123.9, 123.8 (q, $^1J_{C-F}$=271 Hz), 122.8, 54.2, 53.3; IR (neat) 3059, 2861, 1549, 1492, 1321, 1108 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{16}H_{14}F_3N_2$ [M+H], 291.1109; found, 291.1105.

*3.1.33. 2-(4-Benzoic acid methyl ester)-1-phenyl-4,5-dihydro-1H-imidazole (**5e**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4e** (0.517 g, 2.14 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.40 mL, 2.4 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (2%–4% TEA in EtOAc as eluent) to afford the desired product (0.485 g, 81%) as an oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.89 (s, 3H), 4.05–4.09 (m, 4H), 6.77 (dt, *J*=8.0, 1.1 Hz, 2H), 7.00 (tt, *J*=7.4, 1.2 Hz, 1H), 7.14–7.18 (m, 2H), 7.56 (d, *J*=8.4 Hz, 2H), 7.95 (d, *J*=8.6 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.5, 161.9, 142.8, 135.5, 131.2, 129.4, 128.8, 128.6, 123.7, 122.7, 54.1, 53.3, 52.2; IR (neat) 2950, 2869, 1718, 1594, 1495, 1271 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{17}H_{17}N_2O_2$ [M+H], 281.1290; found, 281.1278.

*3.1.34. 2-(4-Chlorophenyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5f**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4f** (0.223 g, 1.02 mmol), CH_2Cl_2 (3 mL), pyridine (0.18 mL, 2.2 mmol), triflic anhydride (0.19 mL, 1.1 mmol), and aniline (0.14 mL, 1.5 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.219 g, 83%) as an oil. The NMR spectral data is consistent with those reported in the literature.[16]

*3.1.35. 2-(2-Iodophenyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5g**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4g** (0.477 g, 1.54 mmol), CH_2Cl_2 (5 mL), pyridine (0.27 mL, 3.3 mmol), triflic anhydride (0.29 mL, 1.7 mmol), and aniline (0.21 mL, 2.3 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.416 g, 77%) as a solid (mp=119–122 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 4.05–4.08 (m, 4H), 6.62–6.67 (m, 2H), 6.90 (tt, *J*=7.4, 1.1 Hz, 1H), 7.04–7.12 (m, 3H), 7.36 (td, *J*=7.4, 1.1 Hz, 1H), 7.40 (dd, *J*=7.6, 1.9 Hz, 1H), 7.78 (dd, *J*=8.0, 1.1 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 162.5, 140.7, 139.4, 137.7, 130.7, 130.3, 128.6, 128.1, 122.3, 119.3, 96.4, 53.0, 51.4; IR (neat) 3063, 2846, 1618, 1597, 1577, 1496, 1375, 1269, 1137 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{15}H_{14}IN_2$ [M+H], 349.0202; found, 349.0218.

*3.1.36. 2-(2-Furanyl)-4,5-dihydro-1-methyl-1H-imidazole (**5h**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4h** (0.180 g, 0.959 mmol), CH_2Cl_2 (3 mL), pyridine (0.19 mL, 2.3 mmol), triflic anhydride (0.19 mL, 1.1 mmol), and aniline (0.14 mL, 1.5 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.158 g, 78%) as a solid (mp=54–59 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.90–3.97 (m, 2H), 4.03–4.09 (m, 2H), 6.31 (d, *J*=1.3 Hz, 2H), 6.97–7.04 (m, 2H), 7.15 (tt, *J*=7.4, 1.1 Hz, 1H), 7.25–7.33 (m, 2H), 7.38 (t, *J*=1.3 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 154.2, 144.6, 143.9, 142.8, 129.0, 125.0, 124.1, 113.7, 111.0, 54.7, 53.2; IR (neat) 3111, 2863, 1624, 1549, 1482, 1279 cm^{-1}; HRMS (ESI): *m/z* calcd for $C_{13}H_{13}N_2O$ [M+H], 213.1028; found, 213.1022.

*3.1.37. 2-Ethyl-1-phenyl-4,5-dihydro-1H-imidazole (**5i**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4i** (0.272 g, 2.00 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (2%–4% TEA in EtOAc as eluent) to afford the desired product (0.344 g, 99%) as a light yellow oil. The NMR spectral data is consistent with those reported in the literature.[23]

*3.1.38. 2-(1-Methylethyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5j**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4j** (0.267 g, 1.78 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration,

the residue was purified by silica gel chromatography (96% EtOAc/4% TEA as eluent) to afford the desired product (0.336 g, 98%) as an oil. The NMR spectral data is consistent with those reported in the literature.[25,34]

*3.1.39. 2-(1,1-Dimethylethyl)-1-phenyl-4,5-dihydro-1H-imidazole (**5k**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4k** (0.333 g, 2.03 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and aniline (0.27 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.397 g, 96%) as a solid (mp=87–90 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.07 (s, 9H), 3.70 (ddd, J=11.4, 9.0, 1.7 Hz, 2H), 3.81 (ddd, J=9.6, 9.0, 1.8 Hz, 2H), 7.24–7.30 (m, 3H), 7.34–7.39 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.0, 144.6, 129.4, 129.2, 127.2, 58.1, 52.2, 34.8, 29.6; IR (neat) 2974, 2869, 1585, 1486, 1177 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{19}N_2$ [M+H], 203.1548; found, 203.1539.

*3.1.40. 2-(1,1-Dimethylethyl)-1-[2,6-di(propan-2-yl)phenyl]-4,5-dihydro-1H-imidazole (**6**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4k** (0.333 g, 2.03 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and 2,6-diisopropylaniline (0.57 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.561 g, 96%) as a solid (mp=108–111 °C). ^{1}H NMR (700 MHz, $CDCl_3$) δ 1.08 (s, 9H), 1.17 (d, J=6.9 Hz, 6H), 1.27 (d, J=6.9 Hz, 6H), 3.12 (sep, J=7.5 Hz, 2H), 3.71 (t, J=10.3 Hz, 2H), 3.91 (t, J=10.3 Hz, 2H), 7.14 (d, J=7.6 Hz, 2H), 7.29 (t, J=7.7 Hz, 1H); ^{13}C NMR (175 MHz, $CDCl_3$) δ 172.1, 147.7, 136.7, 128.7, 124.2, 55.6, 50.2, 35.2, 29.5, 28.2, 26.5, 22.5; IR (neat) 2964, 2865, 1583, 1441, 1360, 1177 cm^{-1}; HRMS (ESI): m/z calcd for $C_{19}H_{31}N_2$ [M+H], 287.2487; found, 287.2486.

*3.1.41. 2-(2,4,6-Trimethylphenyl)-1-(2,6-dimethylphenyl)-4,5-dihydro-1H-imidazole (**7**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4b** (0.225 g, 1.00 mmol), CH_2Cl_2 (3 mL), pyridine (0.17 mL, 2.2 mmol), triflic anhydride (0.19 mL, 1.1 mmol), and 2,6-dimethylaniline (0.18 mL, 1.5 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.249 g, 86%) as an oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 2.16 (s, 3H), 2.19 (s, 6H), 2.21 (s, 6H), 3.82 (t, J=10.2 Hz, 2H), 4.15 (t, J=10.2 Hz, 2H), 6.66 (s, 2H), 6.92 (d, J=7.2 Hz, 2H), 6.97 (dd, J=8.5, 6.3 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 163.2, 137.8, 137.4, 136.9, 136.5, 128.6, 128.3, 128.0, 126.6, 53.4, 51.4, 20.9, 20.8, 19.0; IR (neat) 2971, 2924, 1598, 1470, 1428, 1367, 1217 cm^{-1}; HRMS (ESI): m/z calcd for $C_{20}H_{25}N_2$ [M+H], 293.2018; found, 293.2025.

*3.1.42. 2-Phenyl-1-(phenylmethyl)-4,5-dihydro-1H-imidazole (**8a**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.336 g, 1.83 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and benzylamine (0.33 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.328 g, 76%) as an oil. The NMR spectral data is consistent with those reported in the literature.[25,26]

*3.1.43. 1-[(4-Methoxyphenyl)methyl]-2-phenyl-4,5-dihydro-1H-imidazole (**8b**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.364 g, 1.98 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and 4-methoxybenzylamine (0.39 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.405 g, 77%) as a light yellow solid (mp=77–79 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.38 (t, J=9.9 Hz, 2H), 3.81 (s, 3H), 3.91 (t, J=9.9 Hz, 2H), 4.24 (s, 2H), 6.89 (d, J=8.6 Hz, 2H), 7.17 (d, J=8.7 Hz, 2H), 7.38–7.45 (m, 3H), 7.56–7.63 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.4, 158.9, 131.3, 129.9, 129.8, 128.44, 128.38, 128.1, 114.0, 55.3, 53.2, 52.4, 50.8; IR (neat) 2931, 2876, 1610, 1508, 1389, 1245, 1013 cm^{-1}; HRMS (ESI): m/z calcd for $C_{17}H_{19}N_2O$ [M+H], 267.1497; found, 267.1490.

*3.1.44. 2-Phenyl-1-(diphenylmethyl)-4,5-dihydro-1H-imidazole (**8c**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.187 g, 1.02 mmol), CH_2Cl_2 (3 mL), pyridine (0.17 mL, 2.2 mmol), triflic anhydride (0.19 mL, 1.1 mmol), and diphenylmethanamine (0.27 mL, 1.5 mmol). A modified workup consisted of diluting the reaction mixture in EtOAc and washing with 1 M NaOH solution instead of satd $NaHCO_3$ solution. Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.257 g, 81%) as a solid (mp=107–110 °C). ^{1}H NMR (700 MHz, $CDCl_3$) δ 3.47 (t, J=10.3 Hz, 2H), 3.92 (t, J=10.3 Hz, 2H), 6.10 (s, 1H), 7.13 (d, J=7.5 Hz, 4H), 7.30–7.39 (m, 6H), 7.43 (t, J=7.6 Hz, 2H), 7.49 (t, J=7.4 Hz, 1H), 7.59 (d, J=7.6 Hz, 2H); ^{13}C NMR (175 MHz, $CDCl_3$) δ 167.0, 138.7, 131.0, 128.9, 128.6, 128.29, 128.28, 127.8, 63.5, 50.5, 45.7; IR (neat) 3030, 2854, 1593, 1572, 1403, 1268 cm^{-1}; HRMS (ESI): m/z calcd for $C_{22}H_{21}N_2$ [M+H], 313.1705; found, 313.1693.

*3.1.45. 2-Phenyl-1-(prop-2-yn-1-yl)-4,5-dihydro-1H-imidazole (**8d**).* Prepared according to the general procedure for 2-imidazoline synthesis with **1a** (0.365 g, 1.99 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.37 mL, 2.2 mmol), and propargylamine (0.19 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.283 g, 77%) as a solid (mp=57–58 °C). ^{1}H NMR (700 MHz, $CDCl_3$) δ 2.24 (s, 1H), 3.60 (t, J=9.8 Hz, 2H), 3.88–3.92 (m, 4H), 7.38–7.46 (m, 3 H), 7.55 (d, J=7.4 Hz, 2H); ^{13}C NMR (175 MHz, $CDCl_3$) δ 166.7, 130.4, 129.6, 128.5, 128.0, 78.2, 72.9, 52.2, 50.1, 38.3; IR (neat) 3164, 2844, 2108, 1615, 1599, 1573, 1379 cm^{-1}; HRMS (ESI): m/z calcd for $C_{12}H_{13}N_2$ [M+H], 185.1079; found, 185.1080.

*3.1.46. 1-(1,1-Dimethylethyl)-2-phenyl-4,5-dihydro-1H-imidazole (**8e**).* A solution of **1a** (0.375 g, 2.04 mmol) in CH_2Cl_2 (6 mL) was cooled in an ice bath and treated successively with 2-fluoropyridine (0.40 mL, 4.6 mmol) and triflic anhydride (0.39 mL, 2.3 mmol). The ice bath was removed and the reaction stirred under N_2 atmosphere for 1 h before *t*-butyl amine (0.32 mL, 3.0 mmol) was added. The reaction mixture then refluxed overnight. The reaction was diluted with saturated $NaHCO_3$ solution and the mixture was extracted with CH_2Cl_2 (×3). The pooled organic extracts were dried (Na_2SO_4) and concentrated, and the crude product was purified via silica gel chromatography (2%–4% TEA in EtOAc as eluent) to afford the desired product (0.324 g, 79% yield) as an oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.11 (s, 9H), 3.66 (t, J=9.7 Hz, 2H), 3.80 (t, J=9.9 Hz, 2H), 7.34–7.38 (m, 5H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.4, 134.4, 129.1, 128.4, 127.9, 55.1, 50.8, 48.4, 29.7; IR (neat) 2966, 2917, 2849, 1612, 1584, 1275 cm^{-1}; HRMS (ESI): m/z calcd for $C_{13}H_{19}N_2$ [M+H], 203.1548; found, 203.1552.

*3.1.47. 2-(1,1-Dimethylethyl)-2-(phenylmethyl)-4,5-dihydro-1H-imidazole (**9**).* Prepared according to the general procedure for 2-imidazoline synthesis with **4k** (0.373 g, 2.28 mmol), CH_2Cl_2 (6 mL), pyridine (0.36 mL, 4.4 mmol), triflic anhydride (0.39 mL,

2.3 mmol), and benzylamine (0.33 mL, 3.0 mmol). Following workup and concentration, the residue was purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford the desired product (0.493 g, 97%) as an orange solid (mp=69–72 °C). ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.34 (s, 9H), 3.20 (t, J=10.0 Hz, 2H), 3.67 (t, J=10.0 Hz, 2H), 4.52 (s, 2H), 7.24–7.37 (m, 5H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 172.3, 137.7, 128.6, 127.4, 126.9, 52.7, 51.6, 51.0, 33.6, 28.8; IR (neat) 2974, 1589, 1454, 1277, 1166 cm^{-1}; HRMS (ESI): m/z calcd for $C_{14}H_{21}N_2$ [M+H], 217.1705; found, 217.1715.

*3.1.48. N-[2-(Phenylamino)ethyl]benzamide (**10**).* Prepared as a white solid (mp=125–126 °C) according to a known protocol.[10] ^{1}H NMR (500 MHz, $(CD_3)_2CO$) δ 3.37 (q, J=6.1 Hz, 2H), 3.63 (q, J=6.2 Hz, 2H), 5.13 (broad s, 1H), 6.57 (t, J=7.3 Hz, 1H), 6.66 (d, J=8.6 Hz, 2H), 7.09 (dd, J=8.6, 7.2 Hz, 2H), 7.44 (dd, J=8.3, 6.7 Hz, 2H), 7.51 (t, J=7.3 Hz, 1H), 7.88–7.99 (m, 3H); ^{13}C NMR (125 MHz, $(CD_3)_2CO$) δ 167.9, 149.7, 135.8, 131.9, 129.8, 129.1, 128.0, 117.1, 113.1, 44.1, 40.0; IR (neat) 3362, 1631, 1600, 1577, 1519, 1270 cm^{-1}; HRMS (ESI): m/z calcd for $C_{15}H_{17}N_2O$ [M+H], 241.1341; found, 241.1332. The melting point data is consistent with the literature value (lit. Mp=127 °C).[4d]

*3.1.49. Conversion of **10** to **3a**.* A mixture of **10** (0.0726 g, 0.30 mmol) in CH_2Cl_2 (2 mL), cooled to 0 °C was treated with 2-fluoropyridine (0.06 mL, 0.70 mmol) and triflic anhydride (0.06 mL, 0.36 mmol). The ice bath was removed and the reaction stirred under nitrogen atmosphere at room temperature overnight. The reaction was worked up according to the general procedure for 2-imidazoline synthesis and purified by silica gel chromatography (98% EtOAc/2% TEA as eluent) to afford desired product **3a** (0.040 g, 59%).

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Supplementary data

Supplementary data (^{1}H and ^{13}C NMR spectra for all new compounds) associated with this article can be found in the online version, at http://dx.doi.org/10.1016/j.tet.2016.08.040.

References and notes

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PART 2: Degree-Level Review

Degree Program: BS Forensic Chemistry

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

1. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

2. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

The American Chemical Society is the largest chemical society in the world. Departments have the opportunity to receive ACS accreditation by adhering to quality guidelines. (1) ACS guidelines define curriculum requirements. Recently, the Forensic Chemistry, BS degree was adjusted to include physical chemistry to better mirror American Chemical Society guidelines. Additionally, Organic Chemistry II was changed from CHEM 226 to CHEM 326 in order to allow for higher level learning outcomes. (2) ACS guidelines require state of art, properly maintained instrumentation for use in student learning and research. We have recently acquired an IC, qPCR, thermocycler, MP-AES and 400 MHz NMR that are (3) ACS guidelines require an undergraduate research experience up to 180 hours. Currently, we are working to amend the seminar series to improve student research experiences and dissemination of their work.

Quality, Resources and Support (CC 3.A)

3. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

The BS Forensic Chemistry is an ACS approved program and meets program level and course level outcomes that are appropriate for this professional training. The guidelines can be found at the following:
https://www.acs.org/content/dam/acsorg/about/governance/committees/training/2015-acs-guidelines-for-bachelors-degree-programs.pdf

The official degree audit and the most recent ACS accreditation self-study are attached to this report.

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

4. **Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.**

All students complete a capstone senior project which may constitute up to 180 hours of laboratory time. Research, beginning their junior year or earlier, is faculty lead and culminates in a formal presentation, poster session and senior thesis/report. Many projects are externally grant funded and are presented at national conferences. Additionally, students have gained authorship on peer reviewed publications. A list of student research abstracts is attached to this report.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@Issu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	
Document Title (if attached) or Filename (if emailed):	
This documentation is relevant to Question number:	
Briefly summarize the content of the file and its value as evidence supporting program review:	

Assessment: Program Four Column

Forensic Chemistry - 22oct2018 Assessment_ Program Four Column

Program (CoSE) - Forensic Chemistry BS

Mission Statement: The mission of the forensic chemistry program is to prepare effective, knowledgeable, caring and professional forensic scientists
Assessment Contact: Dr. Steven Johnson

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Knowledge & Skills - The B.S. Forensic Chemistry graduate will demonstrate proficiency in their discipline. **Goal Status:** Active **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations.	Students will successfully complete CHEM351, CHEM445, CHEM495, CHEM499 **Criteria Target:** 100% of students will successfully pass CHEM351, CHEM445, CHEM495, and CHEM499 **High Impact Program Practices 1:** Capstone Course(s), Projects **High Impact Program Practices 2:** Undergraduate Research	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of graduating students successfully completed CHEM 351, 445, 495, 499. (08/23/2018)	**Use of Result:** These four courses are the foundation of the BS Forensic Chemistry program. Will reassess at the department level annually. (08/23/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of graduates successfully completed the aforementioned courses. (05/01/2017)	**Use of Result:** Conversation was initiated at the department level about including CHEM 452. (08/23/2018)
	Students will demonstrate competence in the use of chemical instrumentation and laboratory skills, including safe chemical practices. **Criteria Target:** 100% of students will complete 400 laboratory hours and successfully pass CHEM332 **High Impact Program Practices 1:** Collaborative Assignments, Projects	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students successfully passed CHEM332. (08/20/2018)	**Use of Result:** Goal met. Re-assess annually. (08/22/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students successfully passed CHEM332. (05/01/2017)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
	Students will demonstrate communication and information retrieval skills **Criteria Target:** 100 % of students will successfully pass CHEM495 and CHEM499	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of forensic chemistry majors successfully completed CHEM499. 100% of students successfully completed CHEM 495. (08/23/2018)	**Use of Result:** Goal met. Will continue to reevaluate annually. (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	High Impact Program Practices 1: Capstone Course(s), Projects **High Impact Program Practices 2:** Writing-Intensive Course(s)	**Related Documents:** Chem & Envi Science Senior Thesis Presentations .pdf	
Employability and Readiness for Post-Graduate or Professional Study - The Forensic Chemistry graduate will demonstrate readiness for employment as a laboratory forensic chemist, crime scene investigator or law enforcement laboratory chemist OR graduate or professional study. **Goal Status:** Active	**Indirect - Survey, including self-evaluation, peers, or graduates -** Graduate/Alumni Survey **Criteria Target:** Greater than 50% of students will express satisfaction with their preparedeness for professional employment or graduate/professional study.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Greater than 50% of students self-reported as satisfied with their prepardness (08/23/2018) **Related Documents:** LSSU Graduate Survey Chemistry.xlsx	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes Two students gained entry to graduate school in forensic chemistry. (05/01/2017)	**Use of Result:** Department decided it would be beneficial to generate a graduate survey and to develop a means of maintaining contact with alumni. Possibly a School newsletter. (08/23/2018)
Scholarship - The University supports an active and engaged faculty in chemistry and the forensic applications of chemistry for criminalistics **Goal Status:** Active	**Other Findings**	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Students presented their research involving detection of gunshot residue utilizing MP-AES at the national American Chemical Society Meeting. (06/04/2018)	**Use of Result:** The department needs to look at funding mechanisms to support students with the ability and results to present at national meetings such as this. (08/23/2018)
	Direct - Laboratory, Clinical, Skill/Competency Assessments - The BS Forensic Chemistry student will engage in university-supported faculty led research in forensics. **Criteria Target:** 100% of students will complete a senior research project. **High Impact Program Practices 1:** Undergraduate Research	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students presented results for their senior research projects at the Symposium and Senior Research Presentation. (04/28/2018) **Related Documents:** Chem & Envi Science Senior Thesis Presentations .pdf	**Use of Result:** Goal met. Reassess annually. (08/23/2018)

2015 Periodic Report
to the
ACS Committee on Professional Training

Please consult the ACS Guidelines (http://www.acs.org/cpt) before completing this report. The information contained in this report should pertain only to your undergraduate program. To facilitate committee review, all responses must be provided on this form. Extra pages for the tables are available under the Templates tab on CPRS.

Name of Institution: Lake Superior State University

City, State, and Zip Code: 650 W. Easterday Ave., Sault Sainte Marie MI 49783

Report Prepared by (e.g., Dr. Mary Smith or Juan Ruiz): Dr. Derek D. Wright
E-mail Address: dwright1@lssu.edu
Phone Number: (906) 635-2628

Current Chemistry Department Chair
Name: Dr. Derek D. Wright
Title: Associate Professor

Name of Department: School of Physical Sciences

Section 1

1.1 Degrees Offered in Chemistry (check those offered)
- Bachelor's: ☒
- Master's: ☐
- Ph.D.: ☐

1.2 Number of Calendar Weeks per Term (not counting final exams)
- Semester: 14
- Quarter:
- 4-1-4:
- Other:

1.3 Provide the number of students in the current (most recently completed) academic year:

Entire Campus	2432
Undergraduates	2432
Chemistry Seniors	15
Sum of enrollments in all undergraduate chemistry courses	747

1.4 Provide the number of bachelor's-degree graduates during the past six years who went on to:

Graduate School in the Chemical Sciences	18
Medical and other Professional Schools	5
Industry	14
Teaching	0
Other/Unknown	14

Section 2: Institutional Environment

2.1 Is the institution accredited by a regional accrediting association? Yes ☒ No ☐
Name of Accrediting Association Higher Learning Commission

2.2 Is the chemistry department organized as an independent administrative unit? Yes ☐ No ☒

a. If no, how is the department or program administered and to whom does the department administrator report?

Chemistry is housed within the School of Physical Sciences, which also includes programs in the Environmnetal Sciences, and Geology. The School has a Chair, who reports to the Dean of Natural and Mathmatical Sciences.

b. If no, who controls budgetary, personnel, and teaching decisions for the chemistry program, and how are chemistry faculty involved?

Budgetary, some personnel, and course scheduling decisions are made primarily by the Chair of Physical Sciences, through close consultation with the faculty. These decisions are approved by the Dean.

2.3 Check the Minimum Salary for each Rank of Chemistry Faculty (Nine Months)

Minimum Salary	Professor	Associate Professor	Assistant Professor	Long-term, permanent
Below $51K	☐	☒	☒	☐
$51 - $60K	☒	☐	☐	☐
$61 - $70K	☐	☐	☐	☐
$71 - $80K	☐	☐	☐	☐
$81 - $90K	☐	☐	☐	☐
Over $90K	☐	☐	☐	☐

2.4 Chemistry Expenditures (rough estimates – 2 significant figures):
If your expenditures are over $60,000 per year, excluding internal and external grants, salaries, and library budget, check here ☒ and go to Item 2.5.

	Current	Annual Average Over the Past Five Years
Operating Expenditures Exclusive of Salaries		
Instrument Maintenance and Repair		
Student and Faculty Travel		
Grants		

2.5 Describe whether the level of institutional support allows the department to meet its teaching, infrastructure, and faculty development needs.

The Institution supports 8 faculty & 2 full time staff for lab prep and instrumentation maintenance. Our physical facilities are located in Crawford hall, which was renovated in the year 200. We have 5 instructional labs, one shared instrumentation room, 3 shared research labs dedicated primarily to chemistry instruction and research, and a central stockroom. In addition to the base budget and course fees which generate ~$85,000 annually, the Dean has a discretionary fund for instrument maintenace and replacement, which typically invests ~$40,000 annually in Chemistry equipment. Additional investments typically ~$30,000 annually are made using revenue generated by the Environmental Analysis Lab, a contract lab operated by the School.

Section 3: Faculty and Staff

3.1 Number of Chemistry Faculty in the Spring 2015 Academic Term **(If you have no faculty in a particular category, record a "0").** Please be sure the totals in the top row (Full-time/Part-time totals) add up below.

Faculty	Total Faculty	With Ph.D.	Male	Female	African American	Native American	Asian American	Hispa Ameri
Permanent total	8	8	6	2	0	0	0	0
Full-time	8	8	6	2	0	0	0	0
Tenured	4	4	3	1	0	0	0	0
Pre-tenured	4	4	3	1	0	0	0	0
Long-term, non-tenure track	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0
Tenured	0	0	0	0	0	0	0	0
Pre-tenured	0	0	0	0	0	0	0	0
Long-term, non-tenure track	0	0	0	0	0	0	0	0
Temporary total	0	0	0	0	0	0	0	0
Full-time	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0

3.2 Number of Instructional Staff (Do not include faculty listed in Item 3.1 or Teaching Assistants. **If you have no instructional staff in a particular category, record a "0".**)

Instructional Staff	Total Staff	With Ph.D.	Male	Female	African American	Native American	Asian American	Hispa Ameri
Long-term*	3	2	2	1	0	0	1	0
Full-time	0	0	0	0	0	0	0	0
Part-time	3	2	2	1	0	0	1	0
Temporary	0	0	0	0	0	0	0	0
Full-time	0	0	0	0	0	0	0	0
Part-time	0	0	0	0	0	0	0	0

* Employed for three years or more or expectation of employment for at least three years

3.3 The ACS is concerned about potential overreliance on temporary (part-time and full-time) faculty and instructional staff. If the total number of temporary (full- or part-time) faculty and instructional staff exceeds 50% of the number of permanent faculty and long-term instructional staff listed in items above (3.1 and 3.2 explain their roles in student instruction.

3.4 a. Briefly describe your activities (especially successes) in expanding faculty diversity over the last five years.

Consistant with state and federal laws, LSSU is an equal opportunity employer. All job postings include language encouraging diverse applicants, and positions are posted in the Chronicle of Higher Education, Higher Ed Jobs, and the LSSU Website. One female faculty member in Chemistry was hired in the last 5 years. Two other female faculty, one hispanic, were recently hired in Physics and Env. Sci

b. Describe any attributes of diversity among your faculty not captured in Items 3.1 and 3.2.

None

3.5 a. Number of Support Staff:

Secretarial	0.5
Stockroom	2
Instrument Technicians	
Other	

b. Comment on the adequacy of support staff:

Our suppoert staff consists of one Secretary (shared with Biology) and two full time staff members, a laboratory manager and a technician. The labopratory manager is responsible for managing the stockroom, ordering supplies, and ensureing that instrumentation is in working order. The Technician assists the laboratory manager in the stockroom and with instument maintenance and repair. We also employ 10-15 students 6-8 hrs per week each semster to assist with lab prep. This staffing arrangement has proven to be adequate to support our program.

3.6 Describe the professional development opportunities (including sabbaticals) that are available to chemistry faculty and instructional staff.

The Univeristy provides $1000 annually to faculty which can be used for professional development activities at their discretion. Each acadmic year, 3 semesters of paid sabattical are available to the Full time Faculty (~120 faculty). Two of the current Chemistry faculty have received a full year sabattical in the past 7 years. Additional professional development opportunities include support for seminar speakers and conference attendance through units such as the Faculty Center for Teaching, and the LSSU Foundation.

3.7 Report the number of chemistry faculty and instructional staff who have taken a sabbatical or professional leave in the last six years.

Requested 1

Granted 1

3.8 Teaching Contact Hours for 2014-2015 Academic Year (Classroom and Lab)

Please provide the minimum and maximum numbers that occurred during this academic year. **The ranges reported here should match the numbers reported in Table 3.1.**

a. Contact Hours/week for Chemistry Faculty (exclusive of research):

Range from 10 to 16 ; Average 14.3

b. Contact Hours/week for Instructional Staff:

Range from 2 to 6 ; Average 4

c. If you need to explain how contact hours are counted or if there is a special situation, for example, for online instruction please explain:

d. Are maximum and/or minimum teaching loads established as an institutional policy?

Yes ☒ No ☐

If yes, explain briefly:

Teaching loads are established under the Faculty Association agreement with a minimum of 12 contract hours per semester. One contract hour is equal to one hour of lecture instruction, while one hour of lab instruction is equal to 0.66 contract hours. Teaching load (release time) is awarded to the School Chair (3 hrs per semster) and coordinaters of multiple lab sections. The maximum load is 32 hrs/year

3.9 a. Do you use undergraduate student teaching assistants? Yes ☐ No ☒

If yes, answer items b. and c.

b. Describe the formal instruction and assistance in laboratory and/or classroom teaching provided to undergraduate student teaching assistants.

Table 3.1 – Teaching Contact Hours

Provide the **actual contact hours** per week for each individual involved in undergraduate instruction for the 2014-2015 academic year. List one faculty member per row and enter as many faculty per page as possible. List non-tenure-track faculty, temporary faculty, and instructional staff and **identify them with the key below**. Do not include graduate teaching assistants. If the average number of contact hours for your department is less than 12 contact hours per week, complete Table 3.1 for those individuals with 12 or greater contact hours per week. Additional copies of this table are available under the Template tab on CPRS.

	Fall Semester/1st Quarter 2014				Spring Semester/2nd Quarter 2015		
Faculty Member (list according to rank)	**Course Number and Title**	**1***	**2***	**3***	**Course Number and Title**	**1***	**2***
Curie, Marie (Professor)	CHEM112 – Gen Chem I CHEM 257 – O. Chem I CHEM 358 – O.Chem Lab (2 sections)	3 3 0	0 3 4	13	CHEM257 – Analytical Chemistry CHEM360 – O. Chem II	3 3	3 3
Iretski, Alexei (Professor)	CHEM115 - Gen Chem CHEM362 - P Chem 2 CHEM363 - P Chem Lab	4 3 0	4 0 3	14	CHEM115 - Gen Chem CHEM116 - Intro P Chem CHEM261 - Inorganic Chem CHEM461/462 - Adv Inorg Che	4 0 3 3	0 3 0 3
Werner, R. Marshall (Professor)	CHEM109 - App Chem Lab CHEM110 - App Org & Biochem CHEM351 - Biochem 1	0 3 3	3 0 6	15	CHEM110 - App Org & Biochem CHEM 115 - Gen Chem CXHEM452 - Adv Biochem	3 0 2	4 2 4
Wright, Derek (Associate Professor)	NSCI103 - Env Sci NSCI104 - Env Sci Lab EVRN317 - Env Health App	3 0 3	0 2 3	11	NSCI103 - Env Sci NSCI104 - Env Sci Lab NSCI116 - Oceanography	3 0 3	0 2 2
Heth, Christopher (Assistant Professor)	CHEM116 - Intro P Chem lab CHEM231 - Quant Analysis CHEM499 - Senior Sem HONR101 - Honors Sem 1	0 3 1 3	3 6 0 0	16	CHEM332 - Instrumental Anal CHEM445 - Forensic Sci CHEM499 - Senior Thesis	3 1 1	9 0 0
Johnson, Steven (Assistant Professor)	NSCI110 - Intro to Forensics CHEM115 - Gen Chem CHEM116 - Intro P Chem	3 4 4	2 2 0	15	CHEM116 - Intro P Chem CHEM445 - Forensic Sci	4 2	6 3
Kelly, Megan (Assistant Professor)	CHEM108 - Applied Chem EVRN425 - Env Sysytems NSCI104 - Env Sci lab USEM101 - Univ. Seminar 1	3 3 0 1	3 3 2 0	15	CHEM108 - Applied Chem CHEM115 - Gen Chem CHEM116 - Intro P Chem NSCI104 - Env Sci lab	3 0 0 0	3 2 3 4
Mosey, R. Adam (Assistant Professor)	CHEM110 - App Org & Biochem CHEM225 - Organic Chem 1 HONR302 - Honors Seminar	0 3 3	2 6 0	14	CHEM116 - Intro P chem CHEM226 - Organic Chem 2	0 3	3 9
Blanchard, Roger @ (Adjunct Instructor)	CHEM110 - App Org & Biochem CHEM115 - General Chem	0 0	2 2	4			
Nguyen-Mosey, Thu @ (Adjunct Instructor)	CHEM115 - General Chem CHEM225 - Organic Chem 1	0 0	2 3	5	CHEM225 - Organic Chem 1	3	3
Southwell, Benjamin (Adjunct Instructor)	CHEM115 - General Chem	0	2	2	CHEM261 - Inorganic Chem	0	3

*1 Number of class hours scheduled per week.

*2 Number of contact hours of lab per week.

*3 Total of columns 1 and 2 for a grand total for each individual.

\# Non-tenure faculty

@ Temporary faculty and instructional staf

\+ Long-term instructional staff

Section 4: Infrastructure

4.1 Comment on the adequacy and condition of your department's instruments and lab apparatus to meet your program's teaching and research needs. Describe the arrangements for repair and maintenance of instruments.

Instrumentation maintenance and repair is primarily conducted and coordinated by the science lab manager and the technician, with occasional assistance from faculty. Manufacturer service contracts are also utilized in some instances.

4.2 Do you rely on off-site instrumentation to meet your department's research needs? Yes ☐ No ☒

If yes, please describe the arrangement:

4.3 Comment on the adequacy of the facilities and space available for the undergraduate chemistry program.

We operate 5 instructional labs, 3 shared research labs, and a core instrumentation lab all dedicated to the undergraduate chemistry curriculum. We also share a computer lab which provides access to computational chemistry software (Spartan & Spartan Student). These facilites are properly supplied with safety equpiment including exhaust hoods, gas/vacuum etc., and are adequate to support our program.

4.4 a. Indicate the number of chemistry journals to which students have immediate institutional access on your campus. **If students have access to 30 or fewer chemistry journals, complete Table 4.2.**

30 or fewer ☐ More than 30 ☒

b. Do your students and faculty have access to journals that are not available on campus through interlibrary loan? Yes ☒ No ☐

c. What types of access do undergraduate students and faculty have to chemical information databases on your campus? (Check all that apply.)

Online through ChemSpider	☒
Online through SciFinder	☒
Online through STN	☐
Online through Web of Science	☐
Other access	☐

Specify _____

4.5 What is the maximum number of students in a laboratory section who are directly supervised per faculty member, instructional staff member, or teaching assistant? 24

Table 4.1 – Instrumentation and Specialized Laboratory Apparatus

If you have more than one particular instrument, please list up to two. **Only report functioning instrumentation that is used by undergraduate students.** If your department has more than one of a particular instrument type, please list the two newest.

Instrument/Apparatus	Used by Undergraduates		Year Acquired	Manufacturer and Mod
	In Chemistry Course Work	In Research		
NMR spectrometer(s)	☒	☒	2006	Anasazi EM 360
	☐	☐		
Optical Molecular Spectroscopy	☒	☒		
IR spectrometer(s)	☒	☒	2009	Perkin Elmer Spectrum
	☐	☐		
UV-Vis spectrometer(s)	☒	☒	2010	Mol. Dev. Spectro Max
	☒	☒	2009	Perkin Elmer Lamba 35
Other	☒	☒	2014	Shimadzu BioSpec-nano
Optical Atomic Spectroscopy	☒	☒		
Atomic absorption/emission	☒	☒	2014	Agilent 4200 MP-AES
	☒	☐	2000	Perkin Elmer AAnylist
Other	☐	☐		
Mass Spectrometry	☒	☒		
Mass spectrometer(s)	☒	☒	2003	Agilent 7500a ICP-MS
	☐	☐		
GC-Mass spectrometer(s)	☒	☒	2004	Agilent 6890N Series/5
	☒	☒	2001	HP 5890 Series II/597
Other	☐	☐		
Chromatography and separations	☒	☒		
Gas chromatograph(s)	☒	☒	2000	Agilent 6890 GC/FID (
	☒	☒	2000	Agilent 6890 GC/TCD
Liquid chromatograph(s)	☒	☒	2009	Agilent 1100 PDA (4)
	☒	☒	2004	Waters 2695 PDA/Fluore
Gel electrophoresis	☒	☒	2011	CBS Sci. MGU-102T Hori
	☒	☒	2015	Biorad Mini Protean Ve
Other	☒	☒	2015	Metrohm 930 Ion Chroma
Electrochemistry	☒	☒		
Electrochemical Instrumentation	☒	☒	2014	BASi Epsilon
	☐	☐		
Other	☐	☐		
Other	☒	☒		
Radiochemistry (including counting equipment and sources)	☐	☐		
	☐	☐		
Thermal analysis equipment	☐	☐		
	☐	☐		
Schlenklines and dry box apparatus	☒	☒	2014	2 Schlenklines
	☐	☐		
Imaging microscopy	☒	☒	1993	Jeol 6100 SEM-EDS w/La
	☐	☐		
Other	☒	☒	2010	TS Legend XFR Centrifu
Additional Instruments (over $10,000 in cost):				
	☒	☒	2015	AB StepOne Plus qPCR
	☐	☐		

Table 4.2 – Journal List

Indicate the current chemistry-related periodicals to which students have print or online access. Please use the blanks provided if you have additional journals to list.

General Content

- ☐ Accounts of Chemical Research
- ☐ ACS Central Science
- ☐ Angewandte Chemie Intl Edition in English
- ☐ Chemical Communications
- ☐ Chemical Science
- ☐ Chemistry – A European Journal
- ☐ Chemistry Letters
- ☐ Journal of the American Chemical Society
- ☐ Nature, Nature Chemistry
- ☐ New Journal of Chemistry
- ☐ Proceedings of the National Academy of Science
- ☐ Science

Topical titles

- ☐ ACS Chemical Biology
- ☐ ACS Chemical Neuroscience
- ☐ ACS Medicinal Chemistry Letters
- ☐ ACS Nano
- ☐ Advanced Functional Materials
- ☐ Advances in Heterocyclic Chemistry
- ☐ Advanced Materials
- ☐ Advanced Synthesis and Catalysis
- ☐ Advances in Protein Chemistry
- ☐ Analyst
- ☐ Analytica Chimica Acta
- ☐ Analytical and Bioanalytical Chemistry
- ☐ Analytical Biochemistry
- ☐ Analytical Chemistry
- ☐ Applied Catalysis A
- ☐ Applied Spectroscopy
- ☐ Beilstein Journal of Organic Chemistry
- ☐ Biochemical Journal
- ☐ Biochemistry
- ☐ Biochimica et Biophysica Acta
- ☐ Bioconjugate Chemistry
- ☐ Biomacromolecules
- ☐ Biomaterials
- ☐ Bioorganic Chemistry
- ☐ Bioorganic and Medicinal Chemistry Letters
- ☐ Chemical Education: Research and Practice
- ☐ Chemical Educator
- ☐ Chemistry of Materials
- ☐ ChemPhysChem
- ☐ Chemical Physics Letters
- ☐ Chirality
- ☐ Combinatorial Chemistry and High Throughput Screening
- ☐ Current Opinion in Chemical Biology
- ☐ Dalton Transactions
- ☐ Electrophoresis
- ☐ Environmental Science and Technology
- ☐ European Journal of Inorganic Chemistry
- ☐ European Journal of Organic Chemistry
- ☐ FEBS Journal
- ☐ Green Chemistry
- ☐ Heterocycles
- ☐ Inorganic Chemistry
- ☐ Journal of the American Society for Mass Spectrometry
- ☐ Journal of Applied Polymer Science
- ☐ Journal of Bacteriology
- ☐ Journal of Biological Chemistry
- ☐ Journal of Biological Inorganic Chemistry
- ☐ Journal of Catalysis
- ☐ Journal of Chemical Ecology
- ☐ Journal of Chemical Education
- ☐ Journal of Chemical Information and Modeling
- ☐ Journal of Chemical Physics
- ☐ Journal of Chemical Theory and Computation
- ☐ Journal of Chromatography A, B
- ☐ Journal of Medicinal Chemistry
- ☐ Journal of Molecular Biology
- ☐ Journal of Organic Chemistry
- ☐ Journal of Physical Chemistry A, B, C
- ☐ Journal of Physical Chemistry Letters
- ☐ Journal of Polymer Science Part A
- ☐ Journal of Proteome Research
- ☐ Langmuir
- ☐ Macromolecules
- ☐ Molecular Cell
- ☐ Nanoletters
- ☐ Nature Chemical Biology, Structural and Molecular Biology
- ☐ Nucleic Acids Research
- ☐ Organic and Biomolecular Chemistry
- ☐ Organic Letters
- ☐ Organometallics
- ☐ Physical Chemistry Chemical Physics
- ☐ PLOS One
- ☐ Polymer
- ☐ Polymer Degradation and Stability
- ☐ Supramolecular Chemistry
- ☐ Synlett
- ☐ Synthesis
- ☐ Tetrahedron
- ☐ Tetrahedron Letters

4.6 a. Are the following laboratory facilities **adequate** for your instructional program?

Safety showers	Yes ☒	No ☐	Hoods	Yes ☒	No ☐
Eye washers	Yes ☒	No ☐	Ventilation	Yes ☒	No ☐
Fire extinguishers	Yes ☒	No ☐			

b. If no is checked for any item above, please explain.

4.7 a.

	Yes	No
Does the department/university have established safety rules?	☒	☐
Does the department/university have emergency reporting procedures?	☒	☐
Does your department have a written chemical hygiene plan?	☒	☐
Are there adequate facilities and arrangements for disposal of chemical waste?	☒	☐
Are safety information and reference materials (e.g., MSDS, SDS, SOPs) readily available to all students and faculty?	☒	☐
Is appropriate personal protective equipment available and used by all students and faculty?	☒	☐

b. If no is checked for any of the above, please explain.

c. Does the chemistry department or program have a safety committee or safety officer? Yes ☒ No ☐

If a safety committee exists, how often does it meet? 2 times per semester, or more frequently as needed

Section 5: Curriculum

5.1 a. Are all foundation courses taught annually? Yes ☒ No ☐

b. If no is checked above, indicate the foundation courses that are **not** taught annually.

c. If all of the courses required for student certification are not taught annually, describe how students can complete the requirements for a certified chemistry degree within four years.

Some of the advanced courses are taught on a regular alternate year schedule that is available in advance to both students and faculty advisers. The scheduled meeting times are cooredinated with other departments to prevent/minimize scheduling conflicts.

d. Are at least four semester-long (or six quarter-long) in-depth courses taught annually, exclusive of research? Yes ☒ No ☐

5.2 Refer to section 5.6 of the ACS Guidelines for the definition of degree tracks and **list only those degree tracks that lead to an ACS-certified bachelor's degree** in chemistry or related field.

Track 1 BS Chemistry (ACS)
Track 2 BS Biochemistry (ACS)
Track 3 BS Forensic Chemisty (ACS)
Track 4
Track 5
Track 6
Track 7

5. 3 Please report the number of hours in each course listed below in Table 5.1 that reflects supervised, hands-on lab experience.
CHEM 115 has a total of 28 supervised laboratory hours

Complete Tables 5.1 – 5.4 only for those courses in degree tracks that may lead to an ACS-certified bachelor's degree.

Table 5.1 – Introductory Course Work

List all introductory chemistry course work students may use to prepare for the foundation course work listed in Table 5.2. Do not include courses listed in Table 5.2 and 5.3 or courses that are not used for ACS certification purposes. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Credit Hours	Tracks[2]						
		Class	Lab			1	2	3	4	5	6	7
CHEM 115	General Chemistry	58	28	Chemistry and Chemical Reactivity, Hybrid Edition by Kotz	5	R	R	R	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–
						–	–	–	–	–	–	–

1. Total Hours refers to the total contact hours per term. Do not record credit hours or contact hours per week in this column.
2. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose for each degree track.

Table 5.2 – Foundation Course Work

List below all course work students may use to satisfy the FOUNDATION requirements in the sequence suggested for ACS certification. Do not include courses listed in Tables 5.1 and 5.3 or courses that are not used for ACS certification purposes. Refer to Section 5.3 of the ACS Guidelines for the definition of a foundation course. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	CH[2]	Subdisciplinary % Breakdown[3]					Tracks[4]						
		Class	Lab			A	B	I	O	P	1	2	3	4	5	6	7
CHEM 116	General Chemistry II-Intro to Physical Chemistry	58	42	Chemistry and Chemical Reactivity, Hybrid Edition by Kotz	5			10		90	R	R	R	–	–	–	–
CHEM 225	Organic Chemistry I	44	42	Organic Chemistry, David Klein, 1st Edition	4				100		R	R	R	–	–	–	–
CHEM 231	Quantitative Analysis	44	42	Quantitative Chemical Analysis by D. C. Harris	4	100					R	R	R	–	–	–	–
CHEM 261	Inorganic Chemistry	44	42	Descriptive Inorganic Chemistry. Rayner-Canham and Overton	4			100			R	R	R	–	–	–	–
CHEM 351	Introductory Biochemistry	44	42	Lippincott's Illustrated Review: Biochemistry (Harvey and Ferrier) 5th	4		100				R	R	R	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. State the approximate percentage of each subdiscipline found in each course (analytical chemistry (A), biochemistry (B), inorganic chemistry (I), organic chemistry (O), and physical chemistry (P)). The percentage coverage must add up to 100% for each course. For example, Biophysics I might be 40% biochemistry and 60% physical or Organic Chemistry I might be 100% organic.
4. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose to meet the foundation requirements for each degree track.

Table 5.2 – Foundation Course Work (continued)

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	CH[2]	Subdisciplinary % Breakdown[3]					Tracks[4]						
		Class	Lab			A	B	I	O	P	1	2	3	4	5	6	7
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–
											–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. State the approximate percentage of each subdiscipline found in each course (analytical chemistry (A), biochemistry (B), inorganic chemistry (I), organic chemistry (O), and physical chemistry (P)). The percentage coverage must add up to 100% for each course. For example, Biophysics I might be 40% biochemistry and 60% physical or Organic Chemistry I might be 100% organic.
4. Using the drop-down menu, indicate whether a course is required (R) or one of two or more alternatives (A) that students may choose to meet the foundation requirements for each degree track.

5.4 If any courses are listed as alternative courses in Table 5.2, please explain how students satisfy the foundation requirements for certification for each degree track. List the names and course numbers. If a course is listed here, ensure it is also entered in Table 5.2.

Table 5.3 – In-Depth Course Work

List the in-depth course work used for ACS certification. Do not include courses listed previously in Tables 5.1 and 5.2. Refer to Section 5.4 of the ACS Guidelines for the definition of an in-depth course. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Foundation Prerequisite Course #	CH[2]	Tracks[4]						
		Class	Lab				1	2	3	4	5	6	7
CHEM 226	Organic Chemisty II	44	42	Organic Chemistry, David Klein, 1st Edition	CHEM225	4	R	R	R	–	–	–	–
CHEM 310	Applied Spectroscopy	44	42	Spectrometric Identification of Organic Compounds" (7th ed), R.M. Silverstein, et. al. 2005.	CHEM226 CHEM261	4	E	E	E	–	–	–	–
CHEM 332	Instrumental Analysis	44	42	Undergraduate Instrumental Analysis by J.W. Robinson, E. M. Skelly-Frame, G.M. Frame II, 6th	CHEM 231	4	R	R	R	–	–	–	–
CHEM 341	Environmental Chemistry	44	42	Environmental Chemistry 8th ed S. Manahan	CHEM 231 CHEM 225	4	E	E	E	–	–	–	–
CHEM 353	Introductory Toxicology	44		Casarett & Doull's Toxicology: The Basic Science of Poisons by Klaassen	CHEM 225 CHEM 351	3	E	R	R	–	–	–	–
CHEM 361	Physical Chemistry I	58		Physical Chemistry.Silbey, Alberty, Bawendi, Wiley,4/E 2005	CHEM 116	4	R	E	E	–	–	–	–
CHEM 362	Physical Chemistry II	44		Physical Chemistry. Silbey, Alberty, Bawendy, Wiley,4/E	CHEM 116	3	R	E	E	–	–	–	–
CHEM 363	Physical Chemistry Lab		42	None	CHEM 116	1	R	R	E	–	–	–	–
CHEM 445	Forensic Science	44	42	Forensic Chemistry Handbook by Kobilinsky	CHEM 231 CHEM 332	4	E	E	R	–	–	–	–
CHEM 452	Adv Bochemical and Molecular Tec	28	56	Lippincott's Illustrated Review: Biochemistry (Harvey and Ferrier) 5th Ed	CHEM 351	4	E	R	E	–	–	–	–
CHEM 461	Adv Inorganic Chem	44		Inorganic Chemistry. Miessler, Tarr. 5th Ed, Pearson Education, 2014	CHEM 231 CHEM 225 CHEM 261	3	E	E	E	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

Table 5.3 – In-Depth Course Work (continued)

Dept. & Course Number	Course Title	Total Hours[1]		Textbook and Author	Foundation Prerequisite Course #	CH[2]	Tracks[4]						
		Class	Lab				1	2	3	4	5	6	7
CHEM 462	Adv Inorganic Chem Lab		42	None	CHEM 261	1	E	E	E	–	–	–	–
CHEM 495	Senior Project (undergraduate research)		84	None	N/A	2	R	R	R	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
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							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–
							–	–	–	–	–	–	–

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate the credit hours (CH) for each course listed.
3. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

Table 5.4 – Physics and Mathematics Courses

List the physics and mathematics course work required for ACS certification. Refer to Section 5.7 of the ACS Guidelines. Enter only one course per row.

Dept. & Course Number	Course Title	Total Hours[1]		Department	Credit Hours	Tracks[2]						
		Class	Lab			1	2	3	4	5	6	7
MATH 112	Calculus for Business and Life Sciences	58		Math	4	E		R				
MATH 151	Calculus I	58		Math	4	E	R					
Math 152	Calculus II	58		Math	4	E	R					
Math 305	Linear Algebra	44		Math	2	E		R				
ENGR 245	Calculus Applications for Technology	28	28	Engineering	3	E		R				
PHYS 221	Principles of Physics I	44	28	Physical Sciences	4	E		E				
Phys 222	Principles of Physics II	44	28	Physical Sciences	4	E		E				
PHYS 231	Applied Physics for Engineers and Scientists I	44	28	Physical Sciences	4	E	R	E				
PHYS 232	Applied Physics for Engineers and Scientists II	44	28	Physical Sciences	4	E	R	E				

1. Total hours refers to the total contact hours per term including the final. Do not record credit hours or contact hours per week in this column.
2. Indicate whether a course is required (R) or elective (E) for each track using the drop-down menu.

5.5 How do your ACS-certified graduates **in each degree track** meet the in-depth course requirements? List the names, course numbers, and indicate if required or elective. If a course is listed here, ensure it is also entered in Table 5.3. Where a student may choose among two or more courses, clarify the options, and how many courses are required for certification.

BS Chemistry - Required: CHEM 226 Organic Chemistry II (Organic), CHEM 332 Instrumental Analysis (Analytical), CHEM 361 Physical Chemistry I (Physical), CHEM 362 Physical Chemistry II (Physical), CHEM Electives at the 300 level or higher (11 credits)

BS Biochemistry - Required: CHEM 226 Organic Chemsitry II (Organic), CHEM 332 Instrumental Analysis (Analytical), CHEM 452 Advanced Biochemical Mol Tech (Biochemistry), 4 cr CHEM electives (either CHEM 361 or 362 for certification, Physical)

BS Forensic Chemistry - Required: CHEM 226 Organic Chemistry II (Organic), CHEM 332 Instrumental Ananlysis (Analytical), 3 cr CHEM Electives (must be either CHEM 361 or 362 for certification, Physical)

5.6 How do ACS-certified graduates **in each degree track** meet the laboratory requirement of 400 hours? Include the subdisciplinary area (ABIOP) covered by each course, the course name, the course number, the number of lab hours devoted to each area, and indicate whether courses are required or elective. Please record the total number of labs hours for the courses listed in each track. Do not include lab hours from general or introductory lab courses. If a course is listed here, ensure it is also entered in Table 5.2 or 5.3.

Example: Organic Chemistry II (CH 232), Organic 45 hours

BS Chemistry, Required - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Physical Chemistry Lab (CHEM363), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231); Analytical 42 hrs, Instrumental Analysis (CHEM 332), Analytical 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs; Inorganic Chemistry (CHEM 261); 42 hrs; Senior Project (CHEM 495), 84 hrs. Chemistry Electives also provide additional laboratory hours (minimum 420 hrs.)

BS Biochemistry, Required - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Physical Chemistry Lab (CHEM363), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231); Analytical 42 hrs, Instrumental Analysis (CHEM 332),Analytical 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs; Adv Biochem (CHEM 452), 56 hrs; Inorganic Chemistry (CHEM 261); 42 hrs; Senior Project (CHEM 495) 84 hrs (minumum 476 hrs.)

BS Forensic Chemistry - Intro to Physical Chemistry (CHEM116), Physical 42 hrs; Organic Chemistry I (CHEM 225), 42 hrs; Organic Chemistry II (CHEM 226), Organic 42 hrs; Quantitative Analysis (CHEM 231), Analytical 42 hrs; Instrumental Analysis (CHEM 332) Analytical, 42 hrs; Introductory Biochemistry (CHEM 351), Biochemistry 42 hrs, Inorganic Chemistry (CHEM 261), 42 hrs; Adv Biochemistry (CHEM 452), Biochemistry 56 hrs OR Applied Spectroscopy Analytical, 42 hrs; Senior Project (CHEM 495) 84 hrs. (minimum 420 hrs)

5.7 Describe the computational chemistry facilities and software (e.g., Gaussian) that students use in their course work and research.

A workstation with Spartan '14, and 10 workstations with Spartan Student are available in the instructional computer lab (CRW 107). One additional student workstation with Spartan Student and Titan is available in the introductory chemistry lab (CRW334).

5.8 How do students gain hands-on experience using chemical instrumentation?

Students gain hands on experience with instrumentation throughout the curriculum in both coursework and research. For instance, students in Orgainic Chemistry I (CHEM 225) use NMR and FTIR throughout the semester to characterize their products. Students in Instrumental Analysis (CHEM 332)gain experience with a range of analytical techniques, including instrumentation in each of the five areas of Optical Molecular Spectroscopy, Optical Atomic Spectroscopy, Mass Spectrometry, Chromatography, and Electrochemistry. In dpeth courses with laboratories provide additional hands on opportunities to use instrumentation. For instance, NMR and FTIR are also heavily used in Organic Chemisty II (CHEM 226), and Applied Spectroscopy (CHEM 310). Applied in depth courses such as Environmental Chemistry (CHEM 341) and Forensic Science (CHEM 445)have a strong analytical focus, and make use of a wide range of instrumental methods in the laboratory.

5.9 a. Are any classes required for student certification taught wholly online? Yes ☐ No ☒

b. If you are having problems or concerns with the arrangements for these courses, please describe them.

Section 6: Undergraduate Research

6.1 Undergraduate Research

a. Do you use undergraduate research to fulfill certification requirements for lab hours?
Yes ☒ No ☐

b. Do you use undergraduate research to fulfill certification requirements for in-depth course work?
Yes ☒ No ☐

If yes to either question above, is a comprehensive written report required? Yes ☒ No ☐
If no, go to Item 6.3

6.2 Submit a sample of the comprehensive student research reports or theses representative of multiple disciplines and faculty, with the grade the student received indicated on each report. Also indicate on each report the number of terms (semesters or quarters) and actual student hours per term of research covered by the report.

Number submitted 4 (3-5 reports, 5 maximum)

6.3 Report on the participation in undergraduate research during the last five years.

a. Number of undergraduate majors (all degrees offered by your program) who participated in a research experience: 45

b. Number of chemistry faculty who were regularly involved in research with undergraduates: 7

6.4 If undergraduate research done outside of your institution is used to satisfy certification requirements, are students required to submit a comprehensive written research report that a faculty member at your institution evaluates and approves?

Yes ☒ No ☐ Not applicable ☐

6.5 How are students provided with experiment-specific safety education and training?

In coursework, student receive safety instruction from the instructor prior to beginning each experiment. Students also prepare research proposals in Junior Seminar (CHEM 395) which include sections on experimental methods and laboratory safety. These proposals are reviewed by the department chair and faculty supervisor prior to approval. Students must complete an appropriate safety training program with the laboratory manager, then receive additional safety instruction from the faculty supervisor.

Section 7: Student Skills

7.1 Describe the experiences that develop student professional skills in problem-solving, oral/written/presented communication, teamwork, and ethics (responsible scientific conduct).

While each of these skills is developed in multiple courses throughout the curriculum, problem solving, communication, and ethics are most thoroughly focused on in the CHEM 395, CHEM 495, and CHEM 499 research sequence. In CHEM 395, a research proposal is developed, presented, and revised based on feedback from faculty and other students. Experimental design, and research ethics are also addressed in this course. IN CHEM 495, research is conducted under the close supervision of a faculty mentor. In CHEM 499, The results of the research are presented publicly through a poster symposium, an oral presentation, and a written paper. Teamwork and team problem solving are developed throughout the curriculum through group exercises both in classes and in laboratories.

7.2 Describe how your students gain experience with the effective retrieval and use of chemical literature, data management, archiving, and record-keeping.

Retrieval and use of the chemical literature is taught early in the curriculum beginning with CHEM 225 (typicall fall semester sophomore year). Record keeping is similarly taught thoughout the curriculum through the instruction on and use of proper laboratory notebooks. While laboratory notebooks for coursework are typically not archived, laboratory notebooks, electronic data, and final products for research projects are archived indefinitely (electronic files are backed up on an external server). Additional specific instruction on data management etc. is provided during the undergraduate research sequence.

7.3 Describe how your program conveys safe lab practices and safety risk assessment to students throughout their undergraduate experience. When and where is the first safety instruction delivered?

Safety is taught throughout the curriculum beginning with CHEM 115. At the beginning of each course, a standardized laboratory safety handout is distributed to the students, and safe practices are described by the instructor. Students then sign a form acknowledging they have received general laboroatory safety instruction and the signatures are archived. Instructors also provide additional safety instruction at the beginning of each lab on potential hazards of that days experiment. Students conducting research and student employees must watch a series of videos annually, and pass a safety quiz in addition to receiving specific safety training from the faculty mentor or supervisor.

7.4 How are all of the student skills describe in Items 7.1, 7.2, and 7.3 assessed?

These skills are assessed both qualitatively and quantitatively through a variety of techniques, but the most effective assessment technique involvesobservation and quantitative assessment of students engaging in undergraduate research. Use of the chemical literature is assessed in CHEM 395 Jumior Seminar. During CHEM 495 Senior Project, individual faculty members assess student progress as the research is being executed (including safety, with feedback from routine safety inspections). In CHEM 499 (Senior Thesis) the faculty as a whole provide feedback on the oral and poster presentations, whicle the written paper is evaluated by the faculty mentor and the course instructor.

Section 8: Program Self-Evaluation

8.1 Describe the program self-evaluation activities that your department has undertaken over the past five years. Provide quantitative information, if available.

Lake Superior State University requires comprehensive program review to occur on a regular 5 year rotating schedule. The BS Chemistry & Biochemistry (including secondary ed) degrees were reviewed during the 2013-2014 academic year, while the Forensic Chemistry was reviewed during the 2014-2015 avademic year. The program review documents enrollment trends, staffing levels, graduate placement, student satisfaction, the adequacy of facilities, the acheivement of program learning outcomes, and course level assessment. At LSSU, assessment data for course level and program level learning outcomes is archived in TracDat software. Many courses use ACS exams to evaluate student learning. For example, The past four semesters of general chemistry had class averages of 38.5, 35.7, 37.8, and 40.7 on the 1997 First Semester Exam (average 39.4). Discussions of curriculum items Each fall, the Chemistry Faculty meets to prioritize facilities and instrumentation aquisition and potential funding sources (including submissions to NSF-MRI). LSSU has a fund available to the sciences at the Deans level for replacement of equipment and Instrumentation, and these funds have been used to acquire several instruments designated as priorities by the faculty including a new electrochemical workstation, MP-AES, and Ion Chromatograph in the last two years. Currently, the department is investigating the possibility (and practicality) of acquiring cryogenic NMR to better support research and instruction in Organic Chemistry.

8.2 **Describe how the results of your department's self-evaluations have been used to improve student learning, student skills, exploration of alternate pedagogies, and the effectiveness of the chemistry program.**

Several changes have resulted from the self evaluation process. We have acquired several instruments over the past five years to better support student learning, undergraduate research, and faculty scholarship. We also recently expanded our computational chemistry facilities. We are currently working on curriculum changes to improve the physical chemistry sequesnce, increase student use of computational chemistry software, increase coverage of polymer chemistry, and exapnd the series of seminar courses such that students would take a seminar course in each year of study. The changes to the seminar sequence we expect to particularly improve development of student skills in use of the chemical literature, scientific writing, and career development. We are also working with the English department to explore the possibility of offering specialized course sections of second semester english compsition for STEM majors, with the goal of formally intruducing scientific writing in the freshman year. Other changes include the improvement of safety instruction, including the requirement that students working on undergraduate research projects undergo a more rigorous safety training process than in the past.

Final Comments

Please comment on (in as much detail as you wish) changes in the last five years in faculty, diversity initiatives, professional development, support personnel, facilities, capital equipment, curriculum, and any other items related to your program that you believe would be of interest to CPT. We are especially interested in any new programs you are about to undertake. Use additional sheets, if necessary. Please do not include actual self-evaluation documents or reports.

Over the past five years, we have added an additional full time staff memeber for lab prep and instrument maintenance and repair. We requested campus wide access to SciFinder, and received support from the administration to implement it in 2012. We requested, and were granted, an additional budget for instrument maintenance and replacement through the Deans Fund which totals ~$120,000 annually for the sciences. We added new instrumentation in electrochemistry (electrochemical workstation consiststing of a potentiostat, cell stand, various electrodes, and software) in 2014, which has been incorporated into the instrumental analysis course and undergraduate research. We are also currently investigating the addition of a cryogenic NMR. Additionally, we are pursuing severalcurriculum improvements as described in section 8.2. With regard to facilities, we were granted additional laboratory space in 2011, to support our SEM and to support additional faculty research. In 2014, the university increased annual professional development funds from $800 to $1000, and has also begun redistributing a portion of grant indirect cost revenues to the PI's and the Departments as additional professional development funds.

LAKE SUPERIOR STATE UNIVERSITY

57	19	68	16
La	K	Er	S
138.91	39.10	167.26	32.07

B.S. Forensic Chemistry (Effective 2016)

Name_____ **ID#**_____ **Advisor**_____

Expected Date of Graduation_____ **Chair Approval**_____

Chemistry Degree Requirements (44 cr min)		Sem./Grade
CHEM115 General Chemistry I	5	____/____
CHEM116 General Chemistry II	5	____/____
CHEM225 Organic Chemistry I	4	____/____
CHEM231 Quantitative Analysis	4	____/____
CHEM332 Instrumental Analysis	4	____/____
CHEM351 Intro. Biochemistry	4	____/____
CHEM353 Introductory Toxicology	3	____/____
CHEM361 Physical Chemistry I	4	____/____
CHEM363 Physical Chemistry Lab	1	____/____
CHEM395 Junior Seminar	1	____/____
CHEM/CJUS445 Forensic Science	4	____/____
CHEM452 Adv. Biochem./Mol. Tech.	4	____/____
or		
CHEM310 Applied Spectroscopy	4	____/____
CHEM499 Senior Seminar	1	____/____

Degree Audit Sheet Directions: Fill in the semester and grade for each course as completed. Two semesters before your intended graduation date this form should be filled in indicating the courses you are then taking, and those you will take in the next semester. Have the form signed and submit to the Fletcher Center with your Declaration of Candidacy form. You must have a signed Course Substitution/Waiver Form for any deviations from the audit below – see your advisor for this form.

For American Chemical Society certified degree, additionally required:		
CHEM261 Inorganic Chemistry	4	____/____
CHEM326 Organic Chemistry II	4	____/____
CHEM495 Senior Project	2	____/____
Additional Math: either MATH152 or EGNR140 and EGNR245	(4-5)	____/____ ____/____

See Department Chair for special rules regarding ACS certification.

ACS Chemistry for Life™ AMERICAN CHEMICAL SOCIETY

Criminal Justice (16 credits)		
CJUS101 Intro. to Criminal Justice	3	____/____
CJUS243 Investigation	3	____/____
CJUS319 Substantive Law	3	____/____
CJUS409 Procedural Law	3	____/____
CJUS444 Criminalistics	4	____/____

Support Courses (43 credits)		
BIOL131 Gen. Biology: Cells	4	____/____
BIOL132 Gen. Biology: Organisms	4	____/____
MATH111 College Algebra	3	____/____
MATH112 Calc. for Bus./Life Sci.	4	____/____
MATH207 Prin. of Statistical Meth.	3	
or		
BUSN211 Business Statistics	3	____/____
Two sem. of college physics with lab.	(8 hrs. min)	____/____ ____/____
POLI110 Intro. to Am. Gov./Politics	4	____/____
PSYC101 Introduction to Psychology	4	____/____
PSYC259 Abnormal Psychology	3	____/____
SOCY103 Cultural Diversity	3	____/____
SOCY214 Criminology	3	____/____

OVER

Effective Date: Fall 2016

General Education (25 credits minimum)

ENGL 110 Fresh Comp	3	_____	ENGL111 Fresh Comp II	3	_____
Approved Social Science* (PSYC101)	3	_____	Approved Social Science* (POLI110)	3	_____
HUMN251 Humanities I	4	_____	Approved Humanities*	3	_____
COMM101 Speech	3	_____	Approved Social Div.* (SOCY103)	3	_____

*consult list for approved courses

General Electives credits must be completed for a minimum of 124 total credits

_____ _____ _____

--------Office Use Only----------

___ At MINIMUM of 124 total credits _____ Dean _____ Date

___ 2.5 GPA Overall ___ 2.5 GPA in major

Typical B.S. Forensic Chemistry Sequence ACS Certified Degree (124 Credits Minimum)

Fall Freshman CHEM115 General Chemistry I (5) CJUS101 Introduction to Criminal Justice (3) *MATH111 College Algebra (3) PSYC101 Introduction to Psychology (4) ENGL110 First-Year Composition I (3) Total: 15-18 * If Necessary	Spring Freshman CHEM116 General Chemistry II (5) MATH112 Calculus for Business and Life Sciences I (4) *EGNR140 Linear Algebra and Numerical Methods (2) CJSU243 Investigation (3) ENGL111 First-Year Composition II (3) Total: 15-17 ***If ACS degree desired**
Fall Sophomore CHEM225 Organic Chemistry I (4) CHEM231 Quantitative Analysis (4) (Fall) CJUS319 Substantive Law (3) (Fall) *EGNR245 Calculus Applications for Tech (3) (Fall) PHYS221 Principles of Physics I (4) (Fall) Total: 15-18 ***If ACS degree desired**	Spring Sophomore *CHEM326 Organic Chemistry II (4) (Spring) BUSN211 Business Statistics (3) (or MATH207 Principles of Stats. (3)) BIOL131 Gen. Biology: Cells (4) PHYS222 Principles of Physics II (4) (Spring) Total: 15 ***If ACS degree desired**
Fall Junior CHEM351 Biochemistry I (4) (Fall) PSYC259 Abnormal Psychology (3) CHEM310 Applied Spectroscopy (4) (Fall) Approved Humanities** (3) COMM101 Fundamentals of Speech Com. (3) Total: 17	Spring Junior *CHEM261 Inorganic Chemistry (4) (Spring) CHEM332 Instrumental Analysis (4) (Spring) CHEM353 Toxicology (3) (Spring) CHEM395 Junior Seminar (1) (Spring) SOCY103 Cultural Diversity (3) SOCY214 Criminology (3) (Spring) Total: 14-18 ***If ACS degree desired**
Fall Senior CJUS444 Criminalistics (4) (Fall) BIOL132 Gen. Biology: Organisms (4) POLI110 Intro To American Government/Politics (4) CHEM361 Physical Chemistry I (4) CHEM 363 Physical Chemistry Lab (1) Total: 17 Summer HUMN251 Humanities I (4)	Spring Senior *CHEM495 Senior Project (2) CHEM499 Senior Seminar (1) CHEM452 Advanced Biochem/Mol Tech (4) (Spring) (or CHEM310 Applied Spectroscopy (4)) (Spring) CHEM445 Forensic Science (4) (Spring) CJUS409 Procedural Law (3) (Spring) General Elective (3) Total: 15-17 ***If ACS degree desired**

** Consult official University list of approved General Education Courses

(Fall) = course typically only offered Fall semester, some may be alternate years.

(Spring) = course typically only offered Spring semester, some may be alternate years.

CHEM 499 Abstracts for Forensic Chemistry Majors
Spring 2018

Katelyn Lambert
Major: Forensic chemistry
Abstract: **Abstract**

Microwave plasma atomic emission spectroscopy (MP-AES) is a relatively new analytical technique that has only recently become commercially available. For this work, MP-AES was used to determine levels of Pb, Ba, and Sb in gunshot residue. The MP-AES uses a nitrogen plasma with a temperature of ~5000 K to produce atomic emissions from 178-780 nm. Gunshot residue samples were collected using cotton swabs moistened with 5% HNO_3. Pb, Ba, and Sb were subsequently extracted with 1% HCl, prior to analysis. To improve the sensitivity of Sb, a thin film hydride generator was utilized in addition to a conventional nebulizer to simultaneously introduce Pb and Ba to the plasma as aerosols, and Sb as SbH_3 following reduction to Sb^{3+} by L-Cysteine and reaction with $NaBH_4$. Thin film hydride generation increased sensitivity by a factor of >10x compared to conventional nebulization, allowing detection limits of less than 1 µg, 500 µg, and 1 µg for Pb, Ba, and Sb respectively, which is sufficient to confirm the presence of gunshot reside in single shot test samples. This method will be critical in quantifying gun-shot residue to allow further tests to evaluate any potential differences in bullet manufacturers.

PART 2: Degree-Level Review

Degree Program: ____**Medical Laboratory Science**_____

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

1. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.
   4-Column Program Assessment Report *"2018_09_MLS_Assessment_Program Four Column"* Attached. Please also see attached documents *"2017-2018 MLS-CC Assessment Report"* and its supporting documents ""*2018 Program Review_namesredacted.xlsx"* and *"Equipment and Resources Available to Students_2018.xlsx"*

   Please note that the Medical Laboratory Science major has two concentrations: the Academic Concentration and the Clinical Concentration. The Clinical Concentration is accredited by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS). The Clinical Concentration, specifically, is assessed annually as part of NAACLS accreditation requirements. The educational experiences (courses, graduation requirements) of students in the Academic Concentration are nearly identical to those in the Clinical Concentration, except that the Academic Concentration does not include BIOL 460, the Clinical Internship. All students must begin their studies in the Academic Concentration, but most of them finish the program in the Clinical Concentration. Therefore, the Academic Concentration is not assessed separately from the Clinical Concentration.

2. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

Please see attached document "2017-2018 MLS-CC Assessment Report", Section I.B. "Changes in Response to Findings, and Follow-Up."

Quality, Resources and Support (CC 3.A)

3. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

The mission of the Medical Laboratory Science Program is to train competent entry-level Medical Laboratory Scientists. If our graduates achieve entry-level competence, we deem our degree-level and course-level learning outcomes appropriate. Entry-level competence is measured by surveys of our graduates' employers and by pass rates on the national board certification exam. The results of the most recent employer survey are found on the second tab of the "2018 Program Review_namesredacted.xlsx" document. The results of the most recent graduates' board exams are found on the third tab of the "2018 Program Review_namesredacted.xlsx" document. Degree audits for both the Academic and the Clinical Concentrations of this program are also attached.

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

4. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

All students in the MLS Program must complete a senior research project as a graduation requirement. Their work on this project takes place in the courses BIOL199, BIOL299, BIOL399, BIOL495, and BIOL499. Please see Sections I.A.4 and I.A.5 of the **"2017-2018 MLS-CC Assessment Report"** *and also the sections pertaining to the "Research" and "Written Communication" in* the **"2018_09_MLS_Assessment_Program Four Column"** *for more details. At the end of their senior year, the students present their work in poster, oral presentation, and written paper formats. Several example papers are attached.*

Assessment: Program Four Column

Medical Laboratory Science - 22oct2018 Assessment_ Program Four Column

Program (CoSE) - Medical Laboratory Science BS

Assessment Contact: Dr. Martha Hutchens

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Research - Graduates of the Medical Laboratory Science program will use the scientific method to formulate and test hypotheses **Goal Status:** Active **Goal Category:** Student Learning **Institutional Learning:** ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art.	**Direct - Capstone Project - including undergraduate research -** Medical Laboratory Science students will complete a senior capstone research project culminating in a paper, a poster, and a presentation. **Criteria Target:** All Medical Laboratory Science seniors will receive a B or better grade in BIOL499, the culminating course of the senior research project. **High Impact Program Practices 1:** Undergraduate Research **High Impact Program Practices 2:** Capstone Course(s), Projects	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes All Medical Laboratory Science seniors completing BIOL499 between spring 2017 and spring 2018 received a grade of B or higher. (07/05/2018) **Finding Reporting Year:** 2016-2017 **Goal met:** Yes All Medical Laboratory Science seniors who completed BIOL499 between spring 2014 and fall 2016 earned a B or better in this course. (12/26/2016)	**Use of Result:** Re-assess next cycle. (07/05/2018) **Use of Result:** Re-assess annually (12/26/2016) **Update:** See 2017-2018 Finding (07/05/2018)
External Validity - After completing a clinical internship at appropriate medical institutions, graduates of the Medical Laboratory Science program will be able to obtain a passing score on the Board of Certification exam for Medical Laboratory Scientists **Goal Status:** Active **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating)	**Direct - Exam/Quiz - Standardized -** The pass rate of students graduating from the nationally accredited MLS-Clinical Concentration on the American Society for Clinical Pathology (ASCP) Board of Certification (BOC) exam will be monitored. **Criteria Target:** The 3-year average pass rate for students taking their boards within 1 year of graduation from the program will be 75% or	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes Three (3) of the 3 students (100%) who graduated from the MLS-Clinical Concentration in 2017 passed the BOC exam on their first attempt. (05/30/2018)	**Use of Result:** Goal met. Re-assess next cycle. (05/30/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	greater.		
Written Communication - Graduates of the Medical Laboratory Science Program will communicate clearly in writing **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** High-Level (Creating/Evaluating) **Institutional Learning:** ILO1 - Formal Communication - Students will develop and clearly express complex ideas in written and oral presentations.	**Direct - Capstone Project - including undergraduate research -** Each student will write a paper describing his Senior Thesis research project, including Abstract, Introduction, Methods, Results, Discussion, and Literature Cited. **Criteria Target:** At least 90% of MLS students will receive a B or better on their on their 499 Final Papers (sections listed above; rubric related below). **High Impact Program Practices 1:** Undergraduate Research **High Impact Program Practices 2:** Capstone Course(s), Projects **Related Documents:** BIOL499_Paper_Rubric.pdf	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 10 students have completed senior thesis papers since Spring 2015. I have a record of final scores for 8 of those students, and they all scored above 85%. (08/27/2018) **Related Documents:** 2017-2018 MLS-CC Assessment Report.docx	**Use of Result:** Re-assess in 1-3 years. (08/27/2018)
Professionalism - Graduates of the Medical Laboratory Science Program will exhibit professional behavior and attitudes **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) **Institutional Learning:** ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal.	**Regular, recurring -** Student attendance in the laboratory component of selected courses is monitored **Criteria Target:** In the 300- and 400-level MLS courses linked to this outcome, no more than 1 student per course has more than 2 unexcused absences per semester	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes No more than 1 student per course had more than 2 unexcused absences per semester in any of the 300- and 400- level MLS courses that were taught during the 2017-2018 academic year. (08/27/2018)	**Use of Result:** Re-assess next cycle. (08/27/2018)
	Direct - Field Placement/Internship Evaluation - Clinical instructors will observe and evaluate students' behavioral characteristics during their clinical rotations using the checklist linked to this method. (Multiple categories of behavior, rated on a 1-3 scale, 1 being lowest and 3 highest). **Criteria Target:** No student will	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes None of the 3 students who completed their clinical rotations between January and December 2017 received a score lower than "2" in more than one category on the professionalism checklists. (08/27/2018) **Related Documents:** Professionalism Evaluation Checklist.docx	**Use of Result:** Re-assess in 1-3 years. (08/27/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	receive a lower score than "2" in more than one category on the checklist. **High Impact Program Practices 1:** Internships **Related Documents:** Professionalism Evaluation Checklist.docx		
Clinical Laboratory Result Interpretation - Given a set of clinical laboratory data, graduates of the MLS Program will draw accurate conclusions about the health of the patient and suggest a correct course of action **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying) **Institutional Learning:** ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art.	**Direct - Exam/Quiz - within the course -** This outcome is assessed using selected questions on midterm and final exams in courses related to this outcome: assessed at course level **Criteria Target:** All courses related to this outcome will meet or exceed the target given for their course-level outcome(s) corresponding to this program-level outcome	**Finding Reporting Year:** 2017-2018 **Goal met:** No Of the 3 course-level outcomes pertaining to this program-level outcome assessed in 2 courses, one target was met and the other 2 weren't. The two that were not met was "test interpretation" and "transfusion reactions" in BIOL 406, Immunohematology. The students had a hard time correctly completing antibody ID problems and identifying transfusion reactions. (08/27/2018) **Related Documents:** 2017-2018 MLS-CC Assessment Report.docx	**Use of Result:** Introduce antibody ID problems more systematically and spend more time practicing transfusion reaction identification next time I teach the course (spring 2020). (08/27/2018)
Knowledge - Graduates of the Medical Laboratory Science Program will recall fundamental principles of each discipline used in the medical laboratory **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Low-Level (Understanding/Remembering)	**Direct - Exam/Quiz - within the course -** Selected questions on midterm and final exams in courses related to this outcome: assessed at course level **Criteria Target:** All courses related to this outcome will meet or exceed the target given for their corresponding course-level outcome(s)	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes Of the 6 course-level outcomes pertaining to this program-level outcome that were assessed in 3 courses during AY 2016-2017, 5 of them were met, and there was insufficient data to determine whether or not the 6th was met. (08/27/2018)	
		Finding Reporting Year: 2017-2018 **Goal met:** Yes Of the 5 course-level outcomes pertaining to this program-level outcome that were assessed in 2 courses, the outcome target was met for all 5. (08/27/2018)	**Use of Result:** Re-assess next cycle. (08/27/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
		Related Documents: 2017-2018 MLS-CC Assessment Report.docx	
Clinical Laboratory Quality Evaluation - Graduates of the MLS Program will, given the necessary data, draw accurate conclusions about the quality of a clinical laboratory test and suggest appropriate action **Goal Status:** Active **Goal Category:** Student Learning **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying)	**Direct - Exam/Quiz - within the course -** Specific questions on midterm and final exams in courses related to this outcome: assessed at course level **Criteria Target:** All courses related to this outcome will meet or exceed the target given for their course-level outcome corresponding to this program-level outcome	**Finding Reporting Year:** 2017-2018 **Goal met:** No 2 course-level outcomes in 2 courses were identified as pertaining to this program level course and assessed during the 2017-2018 AY. One of the outcomes was met and the other wasn't. The one that wasn't was the same one in BIOL406 in which students had to correctly complete all the steps of an antibody identification problem, but most of them could not do so by the end of the course. (08/27/2018) **Related Documents:** 2017-2018 MLS-CC Assessment Report.docx	**Use of Result:** Introduce antibody identification more systematically the next time I teach the course (Spring 2020). (08/27/2018)
Skills - Graduates of the Medical Laboratory Science program will safely and accurately perform basic medical laboratory test procedures. **Goal Status:** Active **Goal Level (Bloom/Webb):** Mid-Level (Analyzing/Applying)	**Direct - Laboratory, Clinical, Skill/Competency Assessments -** Students will be evaluated on laboratory skills through homework assignments and/or practical exams in the laboratory portions of courses related to this outcome: assessed at course level **Criteria Target:** All courses related to this outcome will meet or exceed the target given for their course-level outcome corresponding to this program-level outcome	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes See related document "2017-2018 MLS-CC Assessment Report" (08/27/2018) **Related Documents:** 2017-2018 MLS-CC Assessment Report.docx	
	Indirect - Survey, including self-evaluation, peers, or graduates - Alumni survey: Question 2 on the alumni survey asked respondents to rank their level of preparedness in performing and understanding medical laboratory test procedures in each of seven subject areas, and to comment on any specific strengths and weaknesses.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes There have been 3 alumni of the accredited MLS program to date. All 3 responded to the survey. All 3 felt prepared in most areas of laboratory testing, except in Immunology (2 felt unprepared) and Immunohematology (1 felt unprepared). (08/27/2018) **Related Documents:** Alumni Survey LSSU MLS Program df edits.docx	**Use of Result:** This is a small dataset. If the pattern I see in this group continues, I may have to take steps to strengthen the Immunology portion of the program. (08/27/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Related Documents: Alumni Survey LSSU MLS Program df edits.docx **Indirect - Survey, including faculty, supervisors, employers -** Employer survey: Question 2 on the employer survey asked employers of recent graduates of the MLS program to rank the level of preparedness of LSSU graduates in performing and understanding medical laboratory test procedures in each of seven subject areas, and to comment on any specific strengths and weaknesses. **Related Documents:** Employer Survey LSSU MLS Program.docx	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes All 3 employers of all 3 recent graduates of the MLS program ranked the graduates at a "3" or "4" (on a scale of 1-4 with 4 being the highest) on their level of preparedness to perform test procedures. (08/27/2018) **Related Documents:** Employer Survey LSSU MLS Program.docx	**Use of Result:** This result does not support the need for any changes in the program, but it is a very small dataset. Continue to survey employers of recent graduates annually. (08/27/2018)
Employability - Graduates of the Medical Laboratory Science program will obtain clinical internships (if graduating from the Academic Concentration) or employment (if graduating from the Clinical Concentration) in Medical Laboratory Science at appropriate medical institutions **Goal Status:** Active **Goal Category:** Operational Goal, not related to student learning **Goal Level (Bloom/Webb):** Goal is not a student learning outcome.	**Direct - Field Placement/Internship Evaluation -** Each Medical Laboratory Science graduate who applies for a clinical internship will either obtain an internship slot or not. **Criteria Target:** 75% of Medical Laboratory Science graduates who apply for clinical internships after graduation will be placed in one. **High Impact Program Practices 1:** Internships	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes From the end of 2015 to the present, only one student elected to seek an internship placement independently, as a graduate of the Academic Concentration rather than the Clinical Concentration. That student was successful in securing an internship. (05/30/2018)	**Use of Result:** Goal met. Re-assess next cycle. (05/30/2018)
	Indirect - Survey, including self-evaluation, peers, or graduates - Graduates of the MLS-Clinical concentration will be asked whether or not they have obtained employment as medical laboratory scientists within 1 year of program completion.	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes All three students (100%) who graduated from the MLS-Clinical Concentration since its creation in 2014 were employed as medical laboratory scientists within 1 year of program completion. (05/30/2018)	**Use of Result:** Goal met. Continue to monitor employment rates as more students graduate from the program. (05/30/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
	Criteria Target: The three-year cumulative average of the employment rate will 75% or higher.		

LAKE SUPERIOR STATE UNIVERSITY

MEDICAL LABORATORY SCIENCE Academic Concentration
DEGREE AUDIT SHEET
Effective Fall 2016

Name : _____ **ID#** _____ Advisor _____

Intended Month/Year of Graduation _____ Dept Chair Approval _____

General Education

Communication Skills (9 credits)

Course	Grade	Credit	Semester
ENGL110			
ENGL111			
COMM101			

Humanities (7-8 credits)

Choose two courses according to the General Education requirements published in the LSSU Catalog

Social Sciences (6-8 credits)

Choose two courses from different disciplines

Cultural Diversity (3-4 credits) Choose one course

Support Courses (10 credits)

Course	Grade	Credit	Semester
MATH111			
MATH112			
MATH207			

Chemistry Minor (30 credits)

CHEM115			
CHEM116			
CHEM225			
CHEM231			
CHEM326			
CHEM332			
CHEM351			

Biology Core Courses (60 credits)

Course	Grade	Credit	Semester
BIOL131			
BIOL132			
BIOL199			
BIOL204			
BIOL206			
BIOL220			
BIOL280			
BIOL299			
BIOL306			
BIOL330			
BIOL337			
BIOL380			
BIOL399			
BIOL406			
BIOL422			
BIOL423			
BIOL455			
BIOL480			
BIOL495			
BIOL499			

2.0 Overall GPA..... ☐ Yes ☐ No
At least 125 Total Credits..... ☐ Yes ☐ No
2.0 Department GPA ..... ☐ Yes ☐ No
2.5 Chemistry minor GPA ..... ☐ Yes ☐ No
Residency (30 of last 60 credits)..... ☐ Yes ☐ No
Residency (50% of 300/400 courses)..... ☐ Yes ☐ No

I certify that all Departmental requirements are complete and the Departmental grade point average is 2.0 or higher.

_____
Final Approval Date

LAKE SUPERIOR STATE UNIVERSITY

MEDICAL LABORATORY SCIENCE Clinical Concentration
DEGREE AUDIT SHEET Effective Fall 2016

Name : _____ **ID#** _____ Advisor _____

Intended Month/Year of Graduation _____ Dept Chair Approval _____

General Education

Communication Skills (9 credits)

Course	Grade	Credit	Semester
ENGL110			
ENGL111			
COMM101			

Humanities (7-8 credits)

Choose two courses according to the General Education requirements published in the LSSU Catalog

Social Sciences (6-8 credits)

Choose two courses from different disciplines

Cultural Diversity (3-4 credits) Choose one course

Support Courses (40 credits)

Course	Grade	Credit	Semester
MATH111			
MATH112			
MATH207			
CHEM115			
CHEM116			
CHEM225			
CHEM231			
CHEM326			
CHEM332			
CHEM351			

Biology Courses (69 credits)

Course	Grade	Credit	Semester
BIOL131			
BIOL132			
BIOL199			
BIOL204			
BIOL206			
BIOL220			
BIOL280			
BIOL299			
BIOL306			
BIOL330			
BIOL380			
BIOL399			
BIOL406			
BIOL422			
BIOL423			
BIOL455			
BIOL460			
BIOL480			
BIOL495			
BIOL499			

2.0 Overall GPA..... ☐ Yes ☐ No
At least 135 Total Credits..... ☐ Yes ☐ No
2.0 Department GPA ..... ☐ Yes ☐ No
Residency (30 of last 60 credits)..... ☐ Yes ☐ No
Residency (50% of 300/400 courses)..... ☐ Yes ☐ No

I certify that all Departmental requirements are complete and the Departmental grade point average is 2.0 or higher.

_____
Final Approval Date

Medical Laboratory Science—Clinical Concentration
Assessment Report
July 2018

Mission Statement:
The mission of the Lake Superior State University Medical Laboratory Science-Clinical Concentration Program is to train competent entry-level Medical Laboratory Scientists.

Table of Contents

Assessment Report

I. Student Learning Outcomes
Note: A course-by-course and year-by-year breakdown of the below-summarized assessment findings may be found in the attached document "2018 Program Review_namesredacted.xlsx". Further details may be found in the Nuventive Improve™ system; a complete Improve™ report is available upon request.

A. Summary of Findings

1. *(Cognitive) Graduates of the MLS Program will recall fundamental principles of each discipline used in the medical laboratory*
This program-level outcome is the sum of many course-level outcomes. Each of the 6 MLS courses (Medical Laboratory Practices, Medical Mycology, Hematology and Hemostasis, Immunohematology, Body Fluids Analysis, Advanced Clinical Microbiology) has one or more program-level outcomes that pertain to "fundamental principles" of the discipline pertaining to that course. Each academic year, 2-3 courses are selected for assessment of all their outcomes, including the "fundamental principles" outcomes. Over a 4-year cycle, all of the outcomes in all of the courses are assessed at least once. Some course outcomes were assessed multiple times.

Findings of the previous assessment cycle (Spring 2012-Fall 2016):

- The target threshold for 12 of 16 outcomes in the 6 MLS courses were met on the first and any subsequent assessments.

- One (1) course-level outcome was measured once and the target was not met: "Recall principles of erythrocyte, leukocyte, platelet, and coagulation physiology" (Hematology and Hemostasis).

- Two course-level outcomes were measured in multiple years, and changed from "target not met" or "target partially met" to "target met":
  - Recognize and rationalize proper specimen collection and handling techniques. (Medical Laboratory Practices)
  - Recall physiologic and pathological processes causing increased or decreased levels of selected chemical substances in blood and body fluids. (Body Fluids Analysis)

  - One course-level outcome was measured in multiple years and the target was not met: "Recognize safe and unsafe laboratory practices in scenarios of clinical laboratory work" (Medical Laboratory Practices). An action plan for improving this outcome was devised and entered in Nuventive Improve™.

Findings of current assessment cycle (Spring 2017-Spring 2018)

- The target threshold for 8 of the 9 outcomes that were assessed were met.
- There was insufficient data to determine whether or not the ninth outcome's target was met. ("Assign fungi to the correct phylum based on structure and life cycle", BIOL306, Medical Mycology)
- The BIOL380, Hematology and Hemostasis outcome that was not met in the last assessment cycle ("Recall principles of erythrocyte, leukocyte, platelet, and coagulation physiology") was met in the current cycle.
- The BIOL206, Medical Laboratory Practices outcome that was not met in the last assessment cycle ("Recognize safe and unsafe laboratory practices in scenarios of clinical laboratory work") has not yet been re-assessed due to the small class size the most recent time I taught the course.

2. *(Cognitive) Graduates of the MLS Program will, given the necessary data, draw accurate conclusions about the quality of a clinical laboratory test and suggest appropriate action.*

Findings of the previous assessment cycle (Spring 2012-Fall 2016):

- The target threshold was achieved for 5 of the 7 course-level outcomes that were assessed in all years in which they were assessed.
- The target thresholds for two (2) of the outcomes were not met the first time the courses were assessed, but were met in later years.
- One outcome (BIOL206, Medical Laboratory Practices, "Describe principles and practices for assuring quality results in the medical laboratory; apply them to clinical scenarios") was assessed three times, and met the target the first time it was assessed, did not meet the target the second time, and did meet the target the third time.

Findings for the current assessment cycle (Spring 2017-Spring 2018)

- The threshold target was met for 3 of the 4 course-level outcomes that were assessed.
- The threshold target was not met for 1 course level outcome (BIOL406, Immunohematology, "Given clinical and laboratory data concerning a patient, including the results of immunohematologic testing, select the appropriate blood product with which to treat him or suggest additional tests.") This was largely due to the difficulty that students had correctly completing all the steps of an antibody identification problem.
- Note that the current assessment cycle includes data from the new course BIOL460, Clinical Internship.

3. (Cognitive) *Given a set of clinical laboratory data, graduates of the MLS Program will draw accurate conclusions about the health of the patient and suggest a correct course of action.*

Findings for the previous assessment cycle (Spring 2012-Fall 2016)

- The threshold target was met for 7 of the 9 course-level outcomes that were assessed.
- Two of the course-level outcomes varied depending on which year it was assessed and which assessment method was used to assess it. (BIOL480, Advanced Clinical Microbiology "Students will use standard microbiological laboratory techniques to culture, isolate, and identify selected microorganisms"; BIOL380, Hematology and Hemostasis "Use hematologic laboratory data to draw accurate conclusions concerning patient health and suggest appropriate courses of action".)

Findings for the current assessment cycle (Spring 2017-Spring 2018)

- The threshold target was met for 4 of the 7 outcomes that were assessed, including one that had not been met in the last cycle.
- Two outcomes that were met in the last cycle were not met in the current cycle (BIOL406, Immunohematology, "Given clinical and laboratory data concerning a patient, including the results of immunohematologic testing, select the appropriate blood product with which to treat him or suggest additional tests" and "Given clinical and laboratory data concerning a patient, identify whether he is experiencing a transfusion reaction, and if so, and which type it is."). This was due to the difficulty that students had with antibody identification and because they did poorly on exam questions asking about transfusion reactions.
- One outcome was met when exam questions were used as the assessment method, and also when identification of an unknown organism was used, but not when identification of a gram-stained organism was used as the assessment method. This was consistent with the findings in the last assessment cycle.

4. (Cognitive) Graduates of the MLS Program will use the scientific method to formulate and test hypotheses.
   All students in the medical laboratory science program must plan and execute a senior research project, under the guidance of a faculty mentor. The planning stage of this project takes place in BIOL399, Junior Seminar, the data collection takes place during BIOL495, Senior Project, and the final presentation is prepared during BIOL499, Senior Seminar. The faculty mentor must approve each stage of the project plan, and students are graded in each course based on (1) the quality of the project itself and (2) the quality of the student's presentation of the project.

   Findings for previous assessment cycle (Spring 2012-Fall 2016):

   - All 10 MLS students who completed senior thesis projects from 2012 to 2016 earned B+ or higher grades in BIOL399, BIOL495, and BIOL499

   Findings for current assessment cycle (Spring 2017-Spring 2018)

   - All 3 MLS students who completed senior thesis projects from 2017 to 2018 earned B or higher grades in BIOL399, BIOL495, and BIOL499

5. (Cognitive) Graduates of the MLS Program will communicate clearly in writing

In BIOL499, senior seminar, students must present their whole research project in the form of a scientific research paper, including introduction, methods, results, and discussion sections. The papers are graded on the clarity of thought and clarity of presentation that they display.

Findings for previous assessment cycle (Spring 2012-Fall 2016):

- The 5 MLS students whose paper grades I have been able to access all earned an 85% or higher on their final BIOL499 papers.

Findings for current assessment cycle (Spring 2017-Spring 2018)

- The 3 MLS students who completed BIOL499 during this time all earned an 85% or higher on their final BIOL499 papers.

6. *(Psychomotor) Graduates of the MLS Program will safely and accurately perform basic medical laboratory test procedures*

Findings from the previous assessment cycle (Spring 2012-Fall 2016) (observations made in classroom labs):

- When students take their first MLS-specific course in their sophomore year, they struggle to correctly perform common laboratory calculations.
- In Hematology and Hemostasis, students struggled with accurate micropipetting and making good serial dilutions.
- The ability of students to perform (manual) white blood cell differentials is weaker than I'd like it to be.

Findings from current assessment cycle (Spring 2017-Spring 2018)

- After incorporating an extra lab exercise, focusing on pipetting technique, at the beginning of BIOL455, students were able to pipet accurately and make good dilution curves.
- There was an improvement in the ability of the spring 2018 hematology class to perform WBC differentials compared to the ability of the spring 2016 hematology class to perform WBC differentials. This may be due in part to more systematic instruction in WBC identification, or more careful counting of the reference slides by the instructor.

7. (Psychomotor) *Graduates of the MLS Program will demonstrate entry-level competency in medical laboratory test procedures.*

The assessment of is outcome is based entirely on data from clinical rotations, which was not available in the previous assessment cycle.
Findings from the current assessment cycle:

- Assessment of student outcomes in BIOL460 (Clinical Internship) indicated the target threshold for this outcome was met.

- Alumni surveys indicate that alumni, in general, feel prepared to carry out medical laboratory test procedures upon graduation. One respondent lamented the low volume and variety of body fluids tests available during the clinical rotations.
- Employer surveys indicate that employers, in general, are satisfied with the preparedness of LSSU graduates that they hire.

8. (Affective) *Graduates of the MLS Program will exhibit professional behavior and attitudes.*
   Findings for the previous assessment cycle (Spring 2012-Fall 2016):
   - This outcome was assessed in the classroom primarily by recording students' compliance with an attendance policy that required them to notify the instructor *prior to* missing any lab session. The target for this outcome was met for all years of analysis. Also, the instructor of these courses noted only one instance of "unprofessional" student-student interaction among medical laboratory science majors in four years of upper-level MLS courses. No data from clinical rotations was available at this time.

Findings for current assessment cycle (Spring 2016-Spring 2018):

- The target threshold for compliance with the lab attendance policies was met. No instances of "unprofessional" student-student interactions were noted.
- The target threshold for professional behavior as assessed in the clinical rotations was met.

B. Changes In Response to Findings, and Follow-Up

1. Changes made between the previous cycle and the current one in response to the previous cycle's findings
   - Added a new lab exercise in BIOL455 (Clinical Chemistry and Body Fluids Analysis) to address pipetting accuracy and serial dilution preparation.
   - Gave more careful and systematic instruction in BIOL380 (Hematology and Hemostasis) regarding identification of normal white blood cells, also performed a 300-cell differential count on the control slides before evaluating the students' counts.
   - In BIOL206, Medical Laboratory Practices, I emphasized in lecture the difference between the violation of safety principles and the violation of quality principles.

   The first two changes described above were effective in improving students' lab techniques. The effectiveness of the third change has not yet been assessed due to an extremely small class size.

2. Changes planned in response to the current cycle's findings
   - Give more careful and systematic instruction in antibody identification in BIOL406 (Immunohematology)
   - Give more pre-exam practice opportunities in recognizing different kinds of transfusion reactions in BIOL406 (Immunohematology)

II. Resources

A. Summary of Findings

The findings presented in this section are based on the first-hand knowledge of the Program Director, the Chair of the School of Biological Sciences, and the Laboratory Directors of our clinical affiliates, most of whom are members of the Advisory Committee.

1. Personnel:

In the last year, the School of Biological Sciences and the School of Physical Sciences were reorganized so that the Medical Laboratory Science Program and also the Chemistry program are housed in the School of Science and Medicine. Therefore, the resources of the didactic portion of the program correspond to the resources of the School of Science and Medicine.

The geneticist position that was vacant at the last writing has been filled, so now there is an adequate array of expertise to teach the subjects required by in didactic portion of the program.

The upper-level MLS-specific didactic courses are taught by one faculty member- who also serves as the Program Director. So far, this person judges she can successfully wear all those hats, but if and when the program's enrollment grows to the point of needing to offer these courses more frequently than once every two years, additional instructors will be needed. This assessment has not changed since the last cycle.

Each of the Program's clinical affiliates have so far agreed to take no more than one LSSU student per six-month rotation period (or, depending on the affiliate, per year). The laboratory directors at these institutions made that judgment based on their estimation of their lab's workload and personnel resources. LSSU has three regular (ongoing) clinical affiliates, and several more affiliates that may be able to take students irregularly. So far, we have had enough students only to send to one (1) of our regular affiliates.

2. Financial Resources:

The Medical Laboratory Science Program is part of the School of Science and Medicine, and is not budgeted separately from it. The School of Science and Medicine was created in 2018. Prior to the

creation of the School of Science and Medicine, the Medical Laboratory Science Program was part of the School of Biological Sciences. As of this writing (8/24/18), the first budget of the School of Science and Medicine is being developed.

Budget constraints would be eased if School and Program enrollment were higher.

3. Facilities and Equipment:

Note: Item-by-item lists of equipment and resources available to students may be found in the attached document "Equipment and Resources Available to Students_2018.xlsx".

During the previous assessment cycle, the teaching labs on the LSSU campus have benefitted from extensive equipment purchases and upgrades. During the current assessment cycle, a cell culture facility (small room + biological safety cabinet + refrigerator/freezer; CO2 incubator already existed) was added to the on-campus lab space. A point-of-care hemoglobin meter and a point-of-care leukocyte counter were also acquired. Currently, the campus teaching labs are well-equipped to perform basic, traditional microbiological culture techniques, and have new cell culture capability. They also have the equipment necessary to perform most microwell-based assays, basic nucleic acid manipulation and analysis (electrophoresis, PCR, RT-PCR, and a limited degree of DNA sequencing), and basic manual clinical tests (manual cell counts and differentials, spun hematocrits, microscopy of urine sediment, etc.), and some point-of-care automated tests (hemoglobin determination, total leukocyte count). Updated DNA sequencing equipment would make it easier to teach students up-to-date nucleic-acid-based techniques for detecting microbial infections.

The clinical affiliate labs are equipped with the instrumentation necessary for serving patients in the setting of small regional rural hospitals. This is the equipment used by the students. This is adequate for enabling students to meet program outcomes, but it is difficult to give students extensive experience in certain kinds of analyses (e.g. antibody identification, fungal culture, immunologic techniques, body fluids analysis) that are either send-outs or low-volume tests for our affiliates.

It would be nice if I had an automated hematology analyzer capable of performing hemoglobin determinations, erythrocyte counts, leukocyte counts, and leukocyte differentials for our classroom lab. It would also be nice if I had modern blood-typing/antibody detection instrumentation for our classroom lab (I'm still using tube agglutination). However, I don't have a source of funds for either

acquiring or maintaining such equipment, or for the consumables they'd need, and it is hard to justify getting them at current program enrollment levels.

Classroom and laboratory space on the LSSU campus is adequate for enabling students to meet the Program outcomes.

Textbook resources on the LSSU campus and at clinical affiliates are adequate for students to meet Program outcomes, except for those textbooks that students are required to purchase or rent for themselves (1 primary textbook for each course, generally, except a few courses do or may soon require 2 textbooks to cover different portions of the course).

B. Changes in Response to Findings

We are still trying to find funding to purchase an up-to-date gene analyzer.

I am developing promotional material for the program, and aggressively pursing opportunities to increase program visibility, including visiting LSSU charter schools to give presentations about medical laboratory science, and developing articulation agreements with regional community colleges.

III. Program Literature

A. Student Handbook

Updates for 2018-2019 academic year have been made, and the updated Handbook has been posted

B. Program Web page

Is up-to-date as of July 9, 2018

C. Informational flyers

No changes to the informational flyer need to be made. I drafted a promotional flyer, which probably ought to be refined and printed (in color).

D. Program Catalog page

No changes from the current version need to be made

E. Affiliation Agreements

-The Affiliation Agreement with War Memorial Hospital was renewed for a three-year period ending July 1, 2021.

-Affiliation Agreement with Helen Newberry Joy Hospital was renewed for a three-year period ending, July 1, 2021

-The Affiliation agreement with Mackinac Straits Health System expired on July 1 of this year (2018). There are no students currently doing clinical rotations at Mackinac Straits Health System, or planning to do rotations there within the next year.

-A new affiliation agreement was signed with Schoolcraft Memorial Hospital; it expires July 1, 2021
-Affiliation agreements with Aspirus Ironwood and Dickinson County hospital were discussed and/or begun, but completion was not pursued because we are not likely to have enough students to send them within the next two years.

IV. Recommendations for Upcoming Year

A. Student Learning Outcomes

1. Continue to emphasize the difference between safety and quality, re-assess the BIOL206 outcome "Recognize safe and unsafe laboratory practices in scenarios of clinical laboratory work."
2. Continue to develop laboratory exercises that will allow me to assess laboratory skills.

B. Resources

1.Maintain current equipment, replace old or broken items as necessary, guided by equipment replacement schedule prepared by Ben Southwell and Jesse Wesolek.
2. Continue to pursue opportunities to promote the program and increase enrollment.

V. Other Observations and Recommended Changes

A. Clinical Concentration Application Process

- Observation: All students are required to show proof of health insurance, proof of professional liability insurance, and proof of CDC-recommended vaccinations for healthcare workers before beginning their clinical rotations, but not necessarily at the time of admission to the Clinical Concentration. In the past, this practice has resulted in these documentations being overlooked until VERY close to the students' scheduled start date.
- Recommended change: Require students to show insurance and vaccination proofs at the time of application to the Clinical Concentration.
- Observation: All students are required to pass a background check at the time of application to the Clinical Concentration. However, the interval between acceptance into the Clinical Concentration and the beginning of clinical rotations may be 12 months or more, and the War Memorial Hospital Human Resources department requires background checks to be within the last 6 months. Thus, students are forced to pay for a background check twice.
- Recommended change: Perform the background check shortly before students begin their clinical rotations instead of at the time of application to the Clinical Concentration.

B. Timing of MLS introductory course

- Observation: Students who declare the MLS major their freshman year spend that whole year taking courses that are not specific to their field. The first course that's about medical laboratory science is a sophomore-level course, BIOL206, Medical Laboratory Practices. In the meantime, many of those students decide to switch majors.
- Recommended change: Change the current prerequisites for BIOL206 (MATH111, CHEM115, BIOL131) to co-requisites of MATH102 and BIOL131 and advise students to take the course freshman year. Review course content and revise as necessary to enable students who have not yet taken MATH111, CHEM115, and BIOL131 to succeed.
- Expected results of change: The first-to-second year retention rate of MLS majors *may* increase. There will be a greater sense of community among cohorts of MLS majors. Freshman MLS majors will get to know Dr. Hutchens sooner and feel more comfortable approaching her for help.

C. Prerequisites for Animal Physiology

- Observation: BIOL250, Quantitative Biology, is listed as a prerequisite for BIOL330, Animal Physiology. BIOL330 is required for the MLS program, but BIOL250 is not. So far, the instructors teaching BIOL330 have been willing to override MLS students into the course if they have taken MATH207 instead of BIOL250, but this creates extra work for the BIOL330 instructor and puts the MLS students at risk of not being able to complete their degrees.
- Recommended change: Change the prerequisites for BIOL330 (currently CHEM116 and BIOL250) to CHEM116 and (BIOL250 or sophomore statistics course).

D. Prerequisites for upper-level MLS courses

- Observation: the 300- and 400- level MLS courses BIOL380 (Hematology), BIOL406 (Immunohematology), and BIOL455 (Clinical Chemistry and Body Fluids Analysis) have prerequisite lists that are difficult or impossible to complete between freshman year and junior year. Because these courses are offered in alternate years, half of the MLS students must take them in their junior year. I always have to give overrides to allow MLS students to take these upper-level courses that are required for the program.
- Observation: I am no longer sure that second-semester organic chemistry is the best course to prepare students for the chemistry concepts covered in BIOL380, BIOL406, and BIOL455. The chemistry concepts that are actually used in these courses are mostly from general chemistry (pH, buffers, anions, cations, oxidation states of

metals) or from biochemistry (amino acid and protein structure and properties, other biological macromolecules, enzymes).

- Observation: I do not know very much about the curriculum of CHEM332, Instrumental Chemistry, therefore I am not sure to what degree it complements or reinforces BIOL455, for which it is a prerequisite. It is difficult for MLS majors to fit BIOL332 into their schedule at all, let alone before taking BIOL455. I have feedback from a student (an excellent, top-level student) currently taking BIOL455 that the prior courses that have helped her the most are Animal Physiology (BIOL330) and Biochemistry (CHEM351).
- Observation: BIOL406, Immunohematology, includes a lot of immunology concepts, but it is not always possible for students to take BIOL423 (immunology) prior to taking BIOL406.
- Ideal solution: Offer all 300- and 400- level MLS courses, and all their prerequisite courses, every year. However, that is not practical at this time due to the small enrollment of the MLS program.
- Recommended change: Change the prerequisites of BIOL380 (currently CHEM326 and BIOL330) to a pre-requisite of CHEM116 (second-semester General Chemistry), pre-or co-requisite of BIOL330, and junior standing.
- Recommended change: Change the prerequisites of BIOL406 (currently BIOL220, CHEM326, junior standing and permission of instructor) to BIOL220 (Genetics) and junior standing, with a strong recommendation to take BIOL423 (Immunology) if at all possible.
- Recommended change: Change the prerequisites of BIOL455 (currently MATH207, CHEM326, CHEM332, BIOL330) to pre-requisites of CHEM116 (second-semester General Chemistry) junior standing, and a strong recommendation to take BIOL330 (Animal Physiology), CHEM351 (Biochemistry) if at all possible.
- Investigate the contribution of CHEM332 to understanding the material presented in BIOL455 and in the MLS program as a whole. Consider either dropping it from the required courses altogether or else tightly integrating it with the rest of the curriculum.

EQUIPMENT AVAILABLE IN LSSU TEACHING LABS

			Quantity	How Used
		CENTRIFUGES		Used to centrifuge blood specimens, urine specimens, and other mixtures in multiple lab courses, and in research. Rotor sizes can take tubes from 1.5 to 50 mL
230	Biology	VWR Clinical 200 Large Cap. Centrifuge	1	
231	Biology	Beckman Coulter Microfuge 16 Centrifuge	2	
231	Biology	International Micro-capillary centrifuge	1	Used for spun hematocrits in hematology
250	Biology	VWR mini centrifuge	4	
253	Biology	VWR centrifuge and rotors	1	
254	Biology	Beckman Coulter Microfuge 16 Centrifuge	1	
231	Biology	Eppendorf Refrig. Centrifuge 5804/5804 R/5810/5810R with fixed angle & swingi	1	
2548	Biology	Spectrafuge 16M Centrifuge Labnet	1	
		INCUBATORS		Used to incubate microorganisms at 25 degrees or 37 degrees C
230	Biology	VWR Digital Incubation Oven	2	
2548	Biology	Anaerobic Incubator Model 3640 National NAPCO Scientific Company	1	
2548	Biology	Isotemp Incubator Fisher Scientific	1	
2548	Biology	Precision Mechanical Convention Incubator	1	
2548	Biology	Revco Scientific Liquid CO2 Control	1	
2548	Biology	Thermo Forma Series II Water Jacketed CO2 Incubator	1	Can be used for CO2 incubation; currently used for tissue culture for virology course
250	Biology	Thelco Incubation Oven	1	
		REFRIGERATORS AND FREEZERS		Used to store reagents, specimens, and cultures
230	Biology	Fridgiaire Fridge/Freezer combo	1	
230	Biology	Conservator Fridge and Freezer combo	1	
231	Biology	Conservator Fridge and Freezer combo	1	
231	Biology	General Electric Freezer Stand Up	1	
253	Biology	Small Fridge	1	
254	Biology	Conservator Fridge (small)	1	
254	Biology	Crosley Freezer (small)	1	
2548	Biology	Hotpoint Fridge/Freezer combo	1	
2548	Biology	Symphony -80 Freezer	1	
		MICROSCOPES		Used to examine microorganisms, urine sediment, and blood smears in microbiology, body fluids analysis, and hematology courses
230	Biology	Nikon Eclipse E100 Compound Microscope	20	
230	Biology	Nikon Eclipse E200 Compound Microscope	6	
multiple	Biology	Nikon Alphaphot 2 YS2 Compound Microscope	21	
231	Biology	Amscope MD800E	1	
231	Biology	Compound Microscope No. 1012626	1	
249	Biology	Lica Zoom Dissecting Microscope	16	
253	Biology	AmScope Sonra eye piece camera FMA050	1	Used to take photomicrographs
253	Biology	AO Speecer Compound Microscope with Camera	1	
253	Biology	Leica G26 Microscope	1	
253	Biology	Nikon EclipseE600 Microscope (Nikon Y-FL)	1	
253	Biology	Nikon SM2100 Microscope with Schott light source	1	Has light source and filters for fluorescent microscopy
254	Biology	Olympus Microscope	1	
		WATER BATHS, DRY BATHS, HEAT BLOCKS		Used to hold media and reactions at 25-100 degrees C in multiple lab courses
230	Biology	VWR General Purpose Water Bath 10L Digital	1	
249	Biology	Fisher Scientific Dry Bath Heater	1	
250	Biology	Isotemp 205 Hotwater Bath Fisher Scientific	1	
231	Biology	VWR Digital Heatblock	1	
250	Biology	Precision 180 Series Water Bath	2	
2548	Biology	Precision Reciprocal Shaking Bath	1	
249	Biology	VWR Analog Heatblock	1	
		STIR/HOTPLATES		Used to boil media and water in multiple courses
multiple	Biology	VWR stir and Hotplate 7x7 120v STD Cat # 97042-634	7	
231	Biology	VWR Stir and Hotplate	1	
231	Biology	Thermolyne Nuova Stir & Hot Plate	1	
250	Biology	Thermolyne Cimarec 3 hot plate	1	
250	Biology	Thermolyne Hotplate	1	
250	Biology	VWR stir and Hotplate 4X4 Cat # 12365-346	2	
		BALANCES		Used to weigh media and reagents in multiple courses
Multiple	Biology	Ohaus Adventurer AX Precision Balance with draft shield	7	
231	Biology	Ohaus Dial-O-Gram balance	1	
multiple	Biology	VWR A-Series Balance	3	
249	Biology	VWR E-Series Balance	7	
249	Biology	Ohaus Triple Beam Balance	2	
253	Biology	Mettler P163 Scale	1	
		GEL ELECTROPHORESIS EQUIPMENT		Used for DNA electrophoresis in multiple courses, serum electrophoresis in clinical chemistry course
231	Biology	VWR Power Source 300V	2	
231	Biology	VWR gel boxes horizional	8	
231	Biology	ECIOS Elect box Thermo	1	
231	Biology	Fotodyne gel box	2	
254	Biology	Foto/Phoresis FotoDyne Light and Camera	1	
		THERMOCYCLERS		Used to amplify DNA in multiple courses
254	Biology	Applied Biosystems 96 well thermal Cycler	1	
254	Biology	GeneAmp 9700 Thermocycler	1	
		LSSU Medical Laboratory Science students also have access to a _____ thermocycler housed in		Used to prepare thin sections of tissue for staining and examination in histology and histopathology courses
		HISTOLOGY EQUIPMENT		
250	Biology	MT600-XL Microtomy Curybiology	1	
253	Biology	820 Microtome	1	
253	Biology	Tissue-Tekel Paraffin Dispenser	1	
254	Biology	Fisher Slide Warmer Fisher Scientific Company	1	
		AUTOCLAVES		Used to sterilize media and equipment for microbiology courses
2548	Biology	Getinge 40Q/5DDLS-E series steam sterilizer	1	
2548	Biology	Market Forge Sterilmatic Fisher scientific	1	
		OTHER		
231	Biology	Spectronic 20 Genesys	6	used to measure absorbance or optical density in microbiology and clinical chemistry courses, also in introductory biology courses
231	Biology	Vortex Genie Mixer SK223	1	used to thoroughly mix reagents and reactions
231	Biology	VWR Vortex	1	used to thoroughly mix reagents and reactions
249	Biology	Checker by Hannah Ph Meter	21	used to measure the pH of solutions
250	Biology	Goggle UV Sterilizer Cabinet	1	used to disinfect reusable lab goggles
254	Biology	ABI Prism 310 Genetic Analyzer	1	used for analysis of the size and sequence of short lengths of DNA
254	Biology	Leica EMKMR2	1	
254	Biology	Leica Ultracut R	1	
2548	Biology	Barnstead E-Pure Water Filter Systems	1	Used to generate highly purified water for multiple lab courses
2548	Biology	Orion Portable pH Meter Model 250A	1	used to measure the pH of solutions in multiple lab courses
2548	Biology	Scotsman ice machine	1	used to generate ice for keeping reactions at 0 degrees C in multiple lab courses
multiple	Biology	VWR pipette signature single channel set (p10, p20, p200, p1000) with stand	20	Used in multiple lab courses to measure and transfer specimens and reagents
118	Biology	BioTek BIO-Kinetics Reader EL312e Microplate	1	Used to read colorimetric assays in hematology and clinical chemistry courses; used to measure bacterial growth turbidometrically in microbiology courses and research
211	Biology	Portable Refractometer for Salinity	1	Use to measure urine specific gravity
230 and 231	Biology	Biological Safety Cabinets, Type	2	Used to protect students and staff from aerosolized microorganisms and to protect microbial and tissue cultures from contamination
230		Hemocue Hb201 hemoglobin meter	1	Used to measure hemoglobin concentration in blood; mostly used in Hematology class; also for summer science camps
230		Hemocue WBC analyzer	1	Used to measure total WBC counts in mammalian blood; mostly used in Hematology class; also for summer science camps
		CELL CULTURE ROOM, including refrigerator/freezer and biological safety cabinet		New, expected to be used for Virology class and possibly Immunology as well

EQUIPMENT AVAILABLE IN CLINICAL AFFILATE LABORATORIES (examples; list is not comprehensive)

Abbreviations: WMH, War Memorial Hospital, Sault Ste. Marie, MI
HNJH, Helen Newberry Joy Hospital, Newberry, MI
SMH, Schoolcraft Memorial Hospital, Manistique, MI

Affiliate	AUTOMATED CLINICAL CHEMISTRY ANALYZERS
WMH	Vitros 5600
WMH	Dimension EXL
HNJH	Stratus CS
HNJH	Vidas 3
SMH	SEIMENS EXL
SMH	Abbot Piccolo
SMH	BIOMERIFUX Vidas
SMH	i-STAT 100
SMH	Instrumentation Lab GEM-OPL
	AUTOMATED HEMATOLOGY ANALYZERS
WMH	Sysemex-XE 5000
HJNH	Sysmex XN-1000
SMH	Sysmex XN-1000
SMH	Sysmex Pochi
	AUTOMATED/SEMI-AUTOMATED URINALYSIS INSTRUMENTS

How used

Used in statistics courses and in senior research projects to analyze data

Used as source of reliable clinical testing information

MLS Program-Level Outcome Assessment
Jun-16

Outcome 1 **Graduates of the Medical Laboratory Science Program will recall fundamental principles of each discipline used in the medical laboratory**

Course assessed	*Reporting year*	*Course outcome(s)*	*Target met?*	
BIOL206	2013-2014	safety	Yes	Summary: 2012-2013 1 course ass Outcome target met
	2014-2015	safety	No	2013-2014 2 courses ass Outcome target partially met
	2015-2016	safety	No	Note: BIOL206 was taught, but not assessed, in the 20 Areas of weakness: specimen collection and handling (206 exam)
	2013-2014	lab management	yes	blood physiology
	2014-2015	lab management	yes	2014-2015 3 courses ass Outcome target partially met
	2015-2016	lab management	yes	Areas of weakness: Introductory lab safety
	2015-2016	regulations	yes	physiology (clin chem)
	2015-2016	scope of practice	yes	Note that specimen collection and handling target was met in 2014-2015
	2013-2014	specimen collection	no by exam; yes by homework	2015-2016 2 courses ass Outcome target partially met
	2014-2015	specimen collection	yes	Areas of weakness: Introductory lab safety
	2015-2016	specimen collection	yes	Note that specimen collection and handling target was met in 2015-2016
BIOL306	2014-2015	structural terminolc	yes	2016-2017 (s 1 course ass Outcome target met physiology (clin chem) outcome not met in 2014, but met in 2016
	2016-2017	structural terminolc	yes	
	2014-2015	taxonomy	yes	2016-2017 (s 2 more cours Outcome targets partially met
	2016-2017	taxonomy	Insufficient data	Insufficient data to draw any conclusions about the BIOL306 taxonomy outcome
BIOL380	2013-2014	blood physiology	no	2017-2018 2 courses ass Outcome target met
	2017-2018	blood physiology	yes	
	2013-2014	hematologic assays	yes	
	2017-2018	hematologic assays	yes	
BIOL406	2015-2016	blood groups	yes	
	2017-2018	blood groups	yes	
	2015-2016	antibody characteris	yes	
	2017-2018	antibody characteris	yes	
	2015-2016	blood product rules	yes	
	2017-2018	blood product rules	yes	
BIOL455	2014-2015	analysis methods	yes	
	2016-2017	analysis methods	yes	
	2014-2015	physiology	no	
	2016-2017	physiology	yes	
BIOL480	2012-2013	microbial identificat	yes	
	2016-2017	microbial identificat	yes	
	2012-2013	pathogenicity	yes	
	2016-2017	pathogenicity	yes	

Outcome 2 **Graduates of the MLS Program will, given the necessary data, draw accurate conclusions about the quality of a clinical laboratory test and suggest appropriate action**

BIOL206	2013-2014	specimen collection	no by exam; yes by homework	
	2014-2015	specimen collection	yes	Summary: 2012-2013 1 course ass Outcome target met
	2015-2016	specimen collection	yes	2013-2014 2 courses ass Outcome target not met
	2013-2014	quality assurance	yes	Areas of weakness: Specimen collection and handling (BIOL206 exam)
	2014-2015	quality assurance	no	QA (BIOL380; QA OK in BIOL206)
	2015-2016	quality assurance	yes	2014-2015 2 courses ass Outcome target partially met
BIOL380	2013-2014	quality assurance	no	Areas of weakness: QA (BIOL206 only)
	2015-2016	quality assurance	yes	2015-2016 3 courses ass Outcome target met!
	2017-2018	quality assurance	yes	
BIOL406	2015-2016	test interpretation	yes	
	2017-2018	test interpretation	no	
BIOL455	2014-2015	specimen collection	yes	2016-2017 (s 1 course ass Outcome target met
	2014-2015	error identification	yes	
	2016-2017	specimen collection	Yes	2016-2017 (s 2 courses ass Outcome target met
	2016-2017	error identification	yes	
BIOL480	2012-2013	specimen collection	yes	2017-2018 2 courses ass Outcome target not fully met
	2016-2017	specimen collection	yes	test interpretation-- BIOL406
BIOL460	2016-2017	quality	yes	

Outcome 3 **Given a set of clinical laboratory data, graduates of the MLS Program will draw accurate conclusions about the health of the patient and suggest a correct course of action**

BIOL306	2014-2015	identification	yes	
	2016-2017	identification	yes	
	2014-2015	etiology	yes	Summary: 2012-2013 1 course ass Outcome target partially met
	2016-2017	etiology	yes	Areas of weakness: integration of knowledge and lab techniques (480 exam only)
BIOL380	2013-2014	assay interpretation	no (exam only)	2013-2014 1 course ass Outcome target not met
	2015-2016	assay interpretation	yes by exam, no by case study	
	2017-2018	assay interpretation	yes (assessed by exam only)	2014-2015 2 courses ass Outcome target met
BIOL406	2013-2014	immunohematologi	yes	
	2017-2018	immunohematologi	no	2015-2016 2 courses ass Outcome target partially met
	2015-2016	transfusion reaction	yes	
	2017-2018	transfusion reaction	no	Areas of weakness: case studies (BIOL380)
BIOL455	2014-2015	result interpretation	yes	2016-2017 (s 1 course ass Outcome target met
	2016-2017	result interpretation	Yes	2016-2017 (s 2 courses ass Outcome target partly met
BIOL480	2012-2013	integration of know	yes by lab, no by exam	
	2016-2017	integration of know	yes by exam, yes insofar as all students could identify an unknown bacterium, no insofar as a few failed to correctly ID a gram-stained organism;	
	2012-2013	identification	yes	2017-2018 2 courses ass Outcome target partly met
	2016-2017	identification	yes	
	2012-2013	pathogenicity	yes	
	2016-2017	pathogenicity	yes	

Outcome 4 **Graduates of the Medical Laboratory Science program will safely and accurately perform basic medical laboratory test procedures.**

BIOL206	2013-2014	lab math	yes by homework, no by exam	
	2014-2015	lab math	no	Data is scanty. The evaluation of this outcome is an area of the program that needs to be strengthened.
	2015-2016	lab math	no	Most of the data used to evaluate this outcome, for years up to 2015-2016, are based on students' overall scores on lab assignments rather than performance of lab techniques. The 2015-2016 lab dat
BIOL306	2014-2015	lab techniques	yes	The ability of the students to perform laboratory calculations is weaker than I'd like it to be.
	2016-2017	lab techniques	yes	This assessment does include the students' ability to successfully perform specific techniques, but would be better if I separated technique assessment from assessment of ability to explain the procedu
BIOL380	2015-2016	lab techniques	no (stringent criteria)	The ability of students to perform WBC diffs and (manual) spectrophotometric hemoglobin assays is weaker than I'd like it to be.
	2017-2018	lab techniques	yes	
BIOL406	2015-2016	psychomotor	yes	The problem with the hemoglobin assay was primarily a problem with pipetting and making dilutions.
	2017-2018	psychomotor	yes	
BIOL455	2014-2015	lab techniques	no data	Extra lab exercises incorporated into BIOL455 in Fall 2016 following my observation that students struggled with pipetting technique in BIOL380 in spring 2016 were successful in enabling students to ac
	2016-2017	lab techniques	Yes	In BIOL380 in spring 2018, all students obtained WBC differential values within 20% of the instructor's counts for all cell types except eosinophils.
BIOL480	2012-2013	integration of know	yes	
	2016-2017	integration of know	yes by exam, yes insofar as all students could identify an unknown bacterium, no insofar as a few lost points on a gram stains, no insofar as a few lost points on streaking technique	
BIOL460	2016-2017	Clinical test proced	yes	

Outcome 5 **Graduates of the Medical Laboratory Science program will use the scientific method to formulate and test hypotheses**

BIOL399	2017-2018	Junior proposal	yes
BIOL495	2017-2018	proposal + results	yes
BIOL499	2015-2016	Research	Yes
	2015-2016	Hosing	Yes
	2015-2016	MLS students grades	
	2017-2018	senior thesis paper	yes

Outcome 6 **Graduates of the Medical Laboratory Science Program will communicate clearly in writing**

BIOL399	2017-2018	Junior proposal	yes
BIOL495	2017-2018	proposal + results	yes
BIOL499	2015-2016	Presentation	Yes
	2015-2016	MLS students grades	
	2017-2018	senior thesis paper	yes

Outcome 7 **Graduates of the Medical Laboratory Science Program will exhibit professional behavior and attitudes**

BIOL380	2013-2014	Professionalism	yes
	2017-2018	Professionalism	yes
BIOL406	2015-2016	Professionalism	yes
	2017-2018	Professionalism	yes
BIOL455	2014-2015	Professionalism	yes
BIOL455	2016-2017	Professionalism	yes
BIOL499	2015-2016	Integrity	yes
BIOL460	2016-2017	Professionalism	yes

Student	399 grade/year	495 grade/year	499 grade/yeai	Grade on Fir	Grade on 49!	Grade on 499 paper
1	B+(3.3)/F2012	A(4.0)/S2013	B+(3.3)/F2013			
2	B+(3.3)/S2013	A(4.0)/F2013	B(3.0)/S2014			
3	B+(3.3)/S2013	A-(3.7)/Su2013	B(3.0)/F2013	A		
4	B+(3.3)/S2013	A(4.0)/F2013	A-(3.7)/S2014		76	
5	A- (3.7)/S2014	A (4.0)/F2014	A(4.0)/S2015			91
6	A(4.0)/S2014	A(4.0)/F2014	A(4.0)/S2015			99
7	A- (3.7)/S2014	A+(4.0)/F2014	A-(3.7)/S2015			96
8	A(4.0)/S2014	did chem 495 and chem 499			N/A	
9	A(4.0)/S2015	A(4.0)/F2015	A-(3.7)/F2016	90.666667		89.5
10	A(4.0)/F2015	A+(4.0)/F2016	S2017	89.666667	97	
11	B+(3.3)/F2015	A(4.0)/S2016	A-(3.7)/F2016	89.333333	94	87
12	A(4.0)/S2016	A+(4.0)/Su2016	A+(4.0)/S2017		91	98
13	A(4.0)/S2017	A+(4.0)/F2017	A(4.0)/S2018			94
14	A-(3.7)/S2017	A(4.0)/Su2017	B(3.0)/F2017		77 (Intro + M	85
15	A(4.0)/S2018					

399 average proposal grades, final draft

Fall 2014	88
Spring 2015	89
Fall 2015	83

PART 2: Degree-Level Review

Degree Program: A.S. Chemical Technology

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

1. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

2. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

Content in the chemistry courses are the same as those in our ACS accredited program. The course content is consistent with the most recent requirements for industry jobs in chemistry laboratories. This also allows the students in the associate degree track a pathway to earning a bachelor degree, should they choose to do so.

The department is currently assessing the need for this program. Students enrollment has not supported having the program.

Quality, Resources and Support (CC 3.A)

3. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

As mentioned in above, the course –level learning outcomes meet ACS approval. As a result, program-level learning outcomes are at an appropriate level, meeting the current needs of chemical industry across the nation. Additionally, the students are required to take and pass a nationally certified Haz Mat exam.

The degree audit is attached to this report.

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

4. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Students are required to collect, analyze and communicate data in laboratory coursework associated with 200 and 300-level coursework. Students gain additional skills in communicating information in Communication and English classes.

Appendix Cover Sheet

Use a copy of this cover sheet for each document submitted. Evidence supporting the questions and narratives does *not* need to be electronically added to this Program Review form. One option is to use this cover sheet to add content to directly this Word document. A second option is to submit separate documents along with the form, also using this cover sheet for each document provided.

Send email with supporting documentation to: TRACDAT@lssu.edu, with a cc to your dean, or submit as a hardcopy to your dean.

School:	
Document Title (if attached) or Filename (if emailed):	
This documentation is relevant to Question number:	
Briefly summarize the content of the file and its value as evidence supporting program review:	

Assessment: Program Four Column

Chemical Technology AS - 22oct2018 Assessment_ Program Four Column

Program (CoSE) - Chemical Technology AS

Assessment Contact: Dr. Thu Nguyen-Mosey
Mission Statement: The mission of this program is to prepare effective, knowledgeable and professional leaders in the field of chemical technology.

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Knowledge & Skills - The Chemical Technology Graduate will demonstrate proficiency in their discipline. **Goal Status:** Active	Students will successfully complete CHEM326 and CHEM332 **Criteria Target:** 100% of students will successfully pass CHEM326 and CHEM332	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students successfully passed the CHEM332 course. 9% of students received a D and 93% of the students received a C- or greater. (08/20/2018)	**Use of Result:** Goal met, re-assess annually (08/22/2018)
	Students will demonstrate chemical quantitative skills **Criteria Target:** 100% of students will successfully complete CHEM231	**Finding Reporting Year:** 2016-2017 **Goal met:** Yes 94% of students successfully completed CHEM231. 6% of students failed CHEM231. Of the 2 students who failed, one was a criminal justice major and one was a business major. 100% of chemistry students successfully completed the CHEM231 course. (05/01/2017)	**Use of Result:** Goal met. Reassess annually. (05/01/2017)
Readiness for Advanced Study - The Chemical Technology Graduate will demonstrate readiness for advanced coursework in chemistry **Goal Status:** Active	Students will successfully pass CHEM231 and CHEM225 **Criteria Target:** 100 % of students will successfully pass CHEM231 and CHEM225	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 94 % of students successfully completed CHEM231. 6% of the students failed CHEM231. Of these two students who failed the course, one was a criminal justice major and one was a business major. 100% of the chemistry students passed the course. (08/20/2018)	**Use of Result:** Goal met. Re-assess annually. (08/22/2018)
Technical Skills - The Chemical Technology Graduate will demonstrate an operational knowledge of basic chemical instrumentation as used in chemical	Students will successfully complete FIRE312 and CHEM399 **Criteria Target:** 100% of students will successfully pass FIRE312 and CHEM399	**Finding Reporting Year:** 2016-2017 **Goal met:** No 100% of students successfully passed CHEM399. 0% of students passed FIRE312 (did not enroll). (08/23/2018)	**Use of Result:** Only 1 student in the program , but did not enroll in FIRE312. (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
analysis **Goal Status:** Active	**High Impact Program Practices 1:** Internships		

LAKE SUPERIOR STATE UNIVERSITY

57	19	68	16
La	K	Er	S
138.91	39.10	167.26	32.07

Associates Degree: Chemical Technology (Effective Fall 2012)

Name_____ **ID#** _____ **Advisor**_____

Expected Date of Graduation_____ **Chair Approval** _____

		Sem. / Grade
Chemistry Degree requirements (34 credits)		
CHEM115 General Chemistry I	5	____/____
CHEM116 General Chemistry II	5	____/____
CHEM225 Organic Chemistry I	4	____/____
CHEM226 Organic Chemistry II	4	____/____
CHEM231 Quantitative Analysis	4	____/____
CHEM332 Instrumental Analysis	4	____/____
INTD399 Internship in Chemistry	4	____/____
FIRE312 Haz. Mat. Manag.	4	____/____

Degree Audit Sheet Directions: Fill in the semester and grade for each course as completed. Two semesters before your intended graduation date this form should be filled in indicating the courses you are then taking, and those you will take in the next semester. Have the form signed and submit to the Fletcher Center with your Declaration of Candidacy form. You must have a signed Course Substitution/Waiver Form for any deviations from the audit below – see your advisor for this form.

Other Departments & General Education (11 credits)		
BUSN211 Business Stats	3	
Or		
MATH207 Princ. Of Stat. Meth.	3	____/____
MATH131 College Trig.	3	____/____
Two semesters of College Physics	8 cr. min.	____/____ ____/____

Free Electives (6 credits min)

General Education (14 credits		
COMM101 Speech Comm.	3	____/____
ENGL110 Freshman Comp I	3	____/____
ENGL111 Freshman Comp. II	3	____/____

Total Credits: 62

-----Office Use Only----------

___ **At Least 62 total credits** **Dean** _____ **Date**

PART 2: Degree-Level Review

Degree Program: A.S. Chemistry

Explain how the program works to address each of the following questions. For each question, respond with a narrative and supporting evidence.

Assessment (CC 4.B and CC 4.C)

1. Provide evidence that the degree-level program outcomes are clearly stated and are effectively assessed, including the "use of results." Attach the 4-Column Program Assessment Report.

2. Explain how results from degree assessments were used to improve the degree program. Include specific examples.

Content in the chemistry courses are the same as those in our ACS accredited program. The course content is consistent with the most recent requirements for industry jobs in chemistry laboratories. This also allows the students in the associate degree track a pathway to earning a bachelor degree, should they choose to do so.

Quality, Resources and Support (CC 3.A)

3. Explain how the program ensures that degree program-level and course-level learning outcomes are at an appropriate level. Attach evidence, including a degree audit for the program.

As mentioned in above, the course –level learning outcomes meet ACS approval. As a result, program-level learning outcomes are at an appropriate level, meeting the current needs of chemical industry across the nation.

The degree audit is attached to this report.

The Lumina Foundation's Degree Qualification Profile (DQP) is suggested as a resource for answering the questions about what students should know and be able to do at each degree level:
http://degreeprofile.org/wp-content/uploads/2017/03/DQP-grid-download-reference-points-FINAL.pdf

Intellectual Inquiry (CC 3.B).

4. Explain what the program does to engage students in collecting, analyzing, and communicating information; mastering modes of inquiry or creative work; developing skills integral to the degree program. Attach examples of undergraduate research, projects, and creative work.

Students are required to collect, analyze and communicate data in laboratory coursework associated with 200 and 300-level coursework. Students gain additional skills in communicating information in Communication and English classes.

Assessment: Program Four Column

Chemistry AS - 22oct2018 Assessment_ Program Four Column

Program (CoSE) - Chemistry A

Mission Statement: The mission of this program is to prepare effective, knowledgeable and professional leaders in the field of chemistry.
Assessment Contact: Dr. Thu Nguyen-Mosey

Program Outcomes	*Assessment Criteria & Procedures*	*Assessment Results*	*Use of Results*
Knowledge & Skills - The Chemistry Associate Degree Graduate will demonstrate proficiency in their discipline **Goal Status:** Active **Institutional Learning:** ILO3 - Analysis and Synthesis - Students will organize and synthesize evidence, ideas, or works of imagination to answer an open-ended question, draw a conclusion, achieve a goal, or create a substantial work of art.	Students will successfully complete CHEM326 and CHEM332 **Criteria Target:** 100% of students will successfully pass CHEM326 and CHEM332	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students successfully passed CHEM326. (08/23/2018)	**Use of Result:** Goal met - reassess annually. (08/23/2018)
		Finding Reporting Year: 2017-2018 **Goal met:** Yes 100% of students successfully passed CHEM332. Of those 7% scored a D, while 93% scored at C- or higher. (08/20/2018)	**Use of Result:** Re-assess next cycle. (08/22/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students successfully passed CHEM332. (05/01/2017)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)
	Students will demonstrate chemical quantitative skills **Criteria Target:** 100% of students will successfully complete CHEM231	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 94% of students successfully completed CHEM231. 2 out of 22 students failed the course. One of these students was a criminal justice major and one was a business major. So 100% of the students majoring in chemistry passed this course. (08/20/2018)	**Use of Result:** Re-assess next cycle. (08/22/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 94 % (17 out of 18) of the chemistry students passed CHEM231. 6% (1 out of 18) of the chemistry students failed this course. This student was not enrolled in the chemistry	**Use of Result:** Goal met. Reassess annually. (08/23/2018)

Program Outcomes	Assessment Criteria & Procedures	Assessment Results	Use of Results
		associate program. (05/01/2017)	
Readiness for Advanced Study - The Chemistry Associate Degree Graduate will demonstrate readiness for advanced coursework in chemistry **Goal Status:** Active **Institutional Learning:** ILO4 - Professional Responsibility - Students will demonstrate the ability to apply professional ethics and intercultural competence when answering a question, solving a problem, or achieving a goal.	Students will successfully pass CHEM231 and CHEM225 **Criteria Target:** 100% of students will successfully pass CHEM231 and CHEM225	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 94% of students passed CHEM231. 2 students (6% of the class) failed the course. One of these students is a criminal justice major and one is a business major. So 100% of the chemistry majors passed this course. (08/20/2018)	**Use of Result:** Re-assess annually (08/22/2018)
Technical Skills - The Chemistry Associate Degree Graduate will demonstrate an operational knowledge of basic chemical instrumentation as used in chemical analysis **Goal Status:** Active	Students will successfully pass CHEM332 **Criteria Target:** 100% of students will pass CHEM332	**Finding Reporting Year:** 2017-2018 **Goal met:** Yes 100% of students passed the CHEM332 course. 7% of the students received a D and 93% received a C- or greater. (08/20/2018)	**Use of Result:** Re-assess annually (08/22/2018)
		Finding Reporting Year: 2016-2017 **Goal met:** Yes 100% of students successfully passed CHEM332. (05/01/2017)	**Use of Result:** Goal met. Reassess annually. (08/23/2018)

LAKE SUPERIOR STATE UNIVERSITY

57	19	68	16
La	K	Er	S
138.91	39.10	167.26	32.07

Associates Degree: Chemistry (Effective 2016)

Name_____ **ID#** _____ **Advisor**_____
Expected Date of Graduation_____ **Chair Approval** _____

		Sem. / Grade	
Chemistry (26 credits)			
CHEM115 General Chemistry I	5	____/____	
CHEM116 General Chemistry II	5	____/____	
CHEM225 Organic Chemistry I	4	____/____	
CHEM231 Quantitative Analysis	4	____/____	
CHEM326 Organic Chemistry II	4	____/____	
CHEM332 Instrumental Analysis	4	____/____	
Other Departments (19 credits)			
BUSN211 Business Statistics	3		
or			
MATH207 Princ. Of Stat. Meth.	3	____/____	
MATH151 Calculus I	4	____/____	
MATH152 Calculus II	4	____/____	
Two semesters of College Physics	8	____/____	____/____
General Education			
ENGL110	3	____/____	
ENGL 111	3	____/____	
COMM101 Speech	3	____/____	
General Education electives	7		
		____/____	
		____/____	
		____/____	

Degree Audit Sheet Directions: Fill in the semester and grade for each course as completed. Two semesters before your intended graduation date this form should be filled in indicating the courses you are then taking, and those you will take in the next semester. Have the form signed and submit to the Fletcher Center with your Graduation Application. You must have a signed Course Substitution/Waiver Form for any deviations from the audit below – see your advisor for this form.

Students are required to take a minimum of 62 semester credits

OFFICE USE ONLY:

___ At Least 62 total credits
___ 2.5 GPA Overall
___ 2.5 GPA in Department

_____
Dean **Date**

Effective date: Fall 2016